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The Project in Science Teaching*

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The term *project* has made its appearance in educational literature rather frequently during the last few years, particularly in the fields of agriculture, general science, home economics, industrial education and more recently in connection with the administration of the Smith-Hughes Act. The term *project* is used very frequently by science teachers, as a survey of the science literature and the subjects in their educational program will show. Notwithstanding this apparent interest and enthusiasm for the *project method*, there seems to be no uniformity in the use of the term nor any special effort expended to arrive at a clear-cut definition or description of this latest arrival in educational terminology. Since there is no uniformity in the descriptions and definitions of the term *project* it seems worth while to determine whether the contribution it makes could be taken care of by other teaching units or concepts now in use, or to define the idea clearly so that it may take its proper place among other teaching units.

This paper will be devoted mainly to the investigation and solution of the following problems:

1. The determination of certain elements in a type of teaching situation which constitute the *project*. These will be treated as four pairs of contrasted aims in teaching.
2. An examination of the concepts now in use in science teaching for the purpose of estimating their availability for describing the teaching situation now called the project.
3. A statement and explanation of the term *project*.
4. A consideration of the *project* and its relation to problems, thinking, habit formation, action and the curriculum.
5. A statement and discussion of the advantages and shortcomings of the *project method* in science teaching.

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STANDARDS OF JUDGMENTS.

To determine the elements in a type of teaching situation, which constitute a *project,* it is, of course, necessary to set up certain standards of judgment. These have to do, on the one hand, with learning and use of subject matter, and, on the other hand, with certain elements which will later be shown to the implied in the term *project.* These standards will be treated as four pairs of contrasted aims of types of learning, viz:

1. Reasoning and the memory of information.
2. Conduct and information for its own sake.
3. Natural setting for learning and artificial setting for learning.
4. The priority of the problem or of principles.

1. *Reasoning and the memory of information.* Two widely different methods of learning have been and are still used in educational practice. The one measures its success by the ability which the child has to reason; the other by the ability which the child has to appropriate the material outlined in the textbook and give it back when called for during the recitation. This latter method may be termed the acquisition of information by memory. The material in the lessons consists largely of dogmatic statements, and the mental activity demanded of the pupil is reduced largely to reproductive memory. The mental act demanded of the pupils in such exercises is not reasoning, but the mastery of statements outlined and organized by the author. This is clearly shown by the survey of textbooks used by children in the grades and high school. The questions at the close of the chapters in textbooks in physics, chemistry, general science and other science texts may be answered if the child remembers the statements which are given in the text. The activity which the child uses is confined largely to reproductive memory.

The recognition of the inadequacy of memorizing information is not recent, for seventy years ago, Horace Mann pointed out what earlier writers had noticed, viz., that verbal memory received too much attention.

A statement from Mann, quoted because of its humor, illustrates an extreme case of memoriter teaching.

"It recently happened, in a school within my own knowledge, that a class of small scholars in geography, on being examined respect-

ing the natural divisions of the earth—its continents, oceans, islands, gulfs, etc., answered all the questions with admirable precision and promptness. They were then asked, by a visitor, some general questions about their lesson, amongst others, whether they had ever seen the earth about which they had been reading; and they unanimously declared in good faith that they never had."[1]

The defects of the memory exercise were noted early and the correctives which were suggested by Mann and others grew into the concepts of the natural method, thought questions and later into the more elaborate form now known as the problem method sponsored particularly by John Dewey, Frank McMurry, and W. W. Charters.

The most important advantages claimed for the problem method are that it gives a better hold on subject matter and develops a technique of reasoning. It encourages and stirs up self-activity on the part of the child, so that he learns from his own experience.

2. *Conduct and information for its own sake.* The second pair of contrasted aims in types of learning, conduct and information for its own sake, will be considered. It is necessary to distinguish between the completion of an act (conduct) as over against reading about and learning the plan of an act (information).

Conduct as characterized by John Dewey is " a general term for the spirit and tenor of all the overt acts that constitute the behavior of an agent." As contrasted with the term, "behavior," the word, "conduct," is usually limited to acts that have an end consciously in view and that are preceded by more or less deliberation—in short, to such acts as have moral quality, actual or potential.[2]

The implied question which it is necessary to consider is the character of the end of education. Is it the accumulation of information or the modification of conduct?

The answer which all teachers undoubtedly would give is that the modification of conduct is the true end of education. And yet in classroom practice, the mastery of information and not its applications to problems of conduct, is all too frequently made the important end of instruction.

It must be recognized that information does modify conduct but

[1] Life and Works of Horace Mann, vol. 2, p. 68, Lectures and Reports.
[2] Dewey, John. Conduct, Cyclopedia of Education. (Macmillan Co. 1911, Vol. 2, p. 175.)

the modification is not automatic; it is to a very considerable degree both voluntary and conscious. It requires thought to apply information to conduct and this application has such a subtle technic that instruction in the applications of information is necessary.

The act carried to completion guarantees that the solutions will be understood and will become the property of the individual who thus carries it out. Information will then be measured by the extent to which it can be made over into the experience of the individual using it so as to solve his problem.

3. *Natural Setting and Artificial Setting of Problems.* The question of whether the problem is in its natural or artificial setting constitutes the basis for the discussion of the third pair of contrasted aims of teaching. The question that must be answered in determining whether the setting is artificial or natural is this:— Is the problem presented for solution by school room practice essentially different from that found in life outside the school? If the solution is carried on in the same way, then the problem has a natural setting even though it is being solved in the school.

The boy in an agricultural course, who determines to test his father's seed corn as a part of the school work, is carrying on the problem in about the same setting as if he were doing it at any other time. The girl in household science who becomes interested in the canning of fruit for the home as a part of the school work, is likewise carrying on the problem in its natural setting. The making of soap, the testing of baking powder with the home interest in mind are problems in their natural setting.

The criticism, that the subject matter of the school is still largely isolated from the experiences outside the school, is due largely to the fact that few provisions are made for attacking and solving problems in the school in their natural setting.

4. *The Priority of Principles or of Problems.* These rubrics indicate differences in the order in which principles and problems are presented. In the first, the study of principles precedes its applications to a problem; in the second case, the problem is staged for the learner and the principles are introduced when needed.

The foregoing method is commented upon by G. R. Twiss: "As finding the place of a new fact or phenomenon in the general system is always the final step for the scientist in the treatment of a problem, so it should be for the student in the science class. Accordingly the logical position of a new fact should not be given by the

teacher at the start, as so often it is, but should be found by the class after they have studied it."[3] And again, "This fundamental principle of science teaching—withhold theories until they are needed to explain the facts, and allow them to be used only as working hypotheses until the accumulated evidence forces conviction—is flagrantly violated in some of the most widely used texts in both chemistry and physics. In one physics text the wave theory of light comes almost at the beginning of the subject, and the molecular theory is introduced before the phenomena of heat are taken up. In several of the chemistries the authors take the shortest possible cut to the atomic theory. The result is muddy and vague talk by the pupils about what molecules and ether do, when plain statements of fact are required. It leads them inevitably toward a dogmatic, deductive attitude; and it fails to train them in distinguishing between fact and inference—an ability that is absolutely essential to any clear and scientific thinking."[4]

The advantages claimed for the priority of the problem as over against the priority or principles are the following:

1. The principles will be better understood when they are developed as the learner has need for them.

2. The principles learned in this way are learned in the same order that they were learned by the race. The formulation of the principles is the capstone of the observations. It does not come first.

3. There is more interest attached to the formulation of the principles.

The disadvantages claimed are that fewer principles may be given and a systematic outlook might be difficult to obtain. This question will be answered later when the implications of the project method are considered.

THE PROBLEM RESTATED.

Four pairs of standards have been mentioned: (1) information acquired by reasoning; (2) information for its own sake and information for use in modifying conduct; (3) learning in an artificial setting and learning in a natural setting; and (4) the study of principles before the problems in which they are useful as against

[3] Twiss, G. R. Science Teaching, pp. 77-78, 1917 (Macmillan Co., Chicago).
[4] Twiss, G. R. Science Teaching, p. 309, 1917 (Macmillan Co., Chicago) (Quoted from Smith and Hall's Teaching of Chemistry and Physics, Longmans, N. Y., 1902, Chapter VI).

the setting of problems with the introduction of principles as needed in their solution.

It is evident that there might be an important type of teaching situation in which the student would attack a problem in its natural setting, would obtain information in actually modifying his conduct, and would learn his facts and principles as the solution of his problem demanded. If so, there is a demand for a name for such a teaching situation provided no concept now in use denotes these elements and provided the situation is of sufficient educational importance to warrant the invention of a new concept.

The question of whether the situation indicated above is of sufficient importance to warrant the invention of a new concept will be considered first.

That such teaching situations are numerous is clearly shown by the constant recurrence in several fields of instruction. Two fields may be mentioned here as illustrations. The situation in agriculture is stated by R. W. Stimson: "In the ordinary routine of the farm it may be that the boy is required to tend the poultry. During at least one year he should be given control of at least one pen of poultry, and facilities for feeding a balanced ration and trap nesting individual birds for comparison of productivity in laying."[5]

In household science a student is required to assume responsibility for the purchase and preparation of the meals at home for a longer or shorter period, with the understanding that they be well balanced.

These two problems are types of situations not at all uncommon in the agricultural and household science courses which involve the four standards of reasoning and information acquired as it is needed for use in carrying on a practical line of action in its natural setting.

Can the above teaching situation be taken care of by the accepted meanings of concepts now in use in science? If they can, there is no need of a new term in our educational terminology.

AN EXAMINATION OF COMMONLY USED CONCEPTS.

The terms commonly used in accepted science texts are questions, problems, exercises, reviews, illustrations, applications, demonstrations, experiments, topics and practicums. These terms are found

[5] Stimson, R. W. The Home-Project. U. S. Bureau of Education, No. 579, p. 15 (1914).

with sufficient frequency to warrant the statement that they include the concepts now in common use in science teaching.

A critical examination of these concepts was made to see if any one is sufficiently inclusive and exclusive in its scope to provide for the situations cited in household science and agriculture. If all of the four desirable standards are not included, or if any other than the four standards are included, it will be desirable to propose a new concept.

The method by which this examination of all the concepts was made will be illustrated by taking the problem and practicum, which approximate the concept project to see whether they take care of the situations from agriculture and household science cited above. The definition of the term problem, in its general use is given as stated by John Dewey. "Every conscious situation involving reflection presents a distinction between certain given conditions and something to be done with them; the possibility of a change. This contrast and connection of the given and the possible confers a certain problematic, uncertain aspect, upon those situations that evoke thought. There is an element, which may be slight or which may be intense, of perplexity, of difficulty, of confusion. The need of clearing up confusion, of straightening out an ambiguity, of overcoming an obstacle, of covering the gap between things as they are and as they may be when transferred, is, in germ, a problem."[6]

In relation to the eight standards, the problem may lay stress on either the memory of information or reasoning. It usually emphasizes the intellectual phase of the solution rather than its carrying over to modify conduct and it takes into account the natural setting but may, and often does, accept an artificial setting. As interpreted by the leading advocates of the problem method, however, it favors the priority of problem over the statement of principles. It does not, therefore, exclusively include all the standards which are necessary to take care of the type of situations as illustrated from agriculture and household science. The greatest shortcoming of the problem is that the solution is not necessarily carried over into action, but rather emphasizes intellectual activity. The actual carrying of the process over into action as in the preparation of the meals for a limited time and raising of the pen of poultry are not essential to the problem method. Unless the concept of problem as

[6] Dewey, John. Problem, Paul Monroe—Cyclopedia of Education (Macmillan Co., Chicago).

ordinarily used is modified, it will not take care of the items which our proposed concept embraces.

The term *practicum* which represents one of the latest concepts in methods of teaching, is used particularly in agricultural education. It usually means the application of principles learned to the carrying out of an exercise which has economic value and which is of interest to the pupil. The definition given in the Standard Dictionary is "In some colleges and universities an academic exercise consisting of practical work as in the laboratory." Since in the term *practicum* principles are given priority over the problem the term cannot be used, without qualifying, to take care of the teaching situations cited above. The *practicum* makes no provision for arousing the interest of the pupil by placing it in a situation where principles must be developed as needed. In carrying out the situations in household science and agriculture by the practicum method it would be assumed that all the principles had been thoroughly mastered beforehand and that the exercises were merely to illustrate such principles.

An examination of all the concepts used in science shows that in their ordinary meaning they do not exclusively denote a method of teaching, involving reasoning primarily for the sake of modifying conduct in its natural setting and the introduction of principles as they are needed in the carrying out of an act. If any of the foregoing concepts or terms is used, some qualifying adjective would have to be added to it, with attendant complication arising from confusion of meaning.

THE CONCEPT PROJECT PROPOSED.

The concept which is proposed for the situation described in agriculture and household science is the project.

The justification for taking a term that has been in use for some time is that in general the aim of those who use it has been to take care of such situations as cited. The use of the term *project* seems to point to the movement for a term which will accommodate the above mentioned situations. Again, since a few formal definitions have been proposed and since the limits of the *project,* as interpreted from the literature have not been clearly drawn, it would seem advantageous to use it as our term and avoid the necessity of proposing another one. By so doing we should avoid the confusion

which might come later in the use of the term *project* and the new concept proposed.

DEFINITION OF THE PROJECT.

The definition of the project which is proposed for substantiation is the following:

A project is a problematic act carried to completion in its natural setting.

In this definition note that (1) it implies an act carried to completion as over against the passive absorption of information; (2) it develops the problematic situation demanding reasoning rather than merely the memorizing of information; (3) it implies by emphasizing the problematic aspect, the priority of the problem over the statement of principles, and (4) it makes provision for the natural setting of problems as over against an artificial setting.

For the sake of clearness a brief discussion of these particular phases of the definition will be given.

(1) The presentation of subject matter or the staging of a situation which results in activity, in carrying out the act to completion as over against the passive acceptance of information is one of the most significant contributions of the project. For the term, act, or action, the definition of E. B. Titchener may be accepted. "In its most general meaning, an action is an organized movement, less generally, it is a movement of a locomotor organism. The characteristic feature of the action consciousness, as distinguished from the consciousness so far considered, is its predetermination in the sense of the idea of end."[7]

In ordinary usage of the term, activity, means the contraction and relaxation of muscles in physical activity. For educational purposes the meaning should be broadened to include the situation defined by Dewey "as a series of changes definitely adapted to accomplishing an end. Hence it is opposed to restless and random changes, as well as to mere quiescence and passive absorption. Dictated exercises * * * when not accompanied by any sense of a result to which they naturally contribute, are not activity in its genuine, or intellectual, significance; neither is undirected overflow of motor impulse."[8]

[7] Titchener, E. B. A Text Book in Psychology, pp. 448-449 (Macmillan & Co., Chicago).

[8] Dewey, John. Activity, Monroe, Paul. Cyclopedia of Education (Macmillan Co., Chicago).

There are many different kinds of activity, intellectual, social, religious and physical. The *project* does not limit itself to physical activities alone but makes provision for these other acts, provided the individual takes a part in the purpose, choice and reflection of the directed action. Thus "physical activity when not accompanied by any sense of the result" is not considered activity but intellectual activity when accompanied by a sense of result is considered an activity in an educational sense.

The expression, problematic act, has been formulated and used in the definition of *project* for the distinct purpose of emphasizing not only the act but also the problematic aspect of the act.

(2) It is essential that the *project* be understood to include a problem, otherwise it could not be differentiated from habits and reflexes such as digestion, respiration, or from knitting and dish-washing after they have become habitual. The *project* may include habits and reflexes, provided in addition, there is involved a problem, a situation demanding reasoning for a solution.

(3.) The problem aspect of the *project* not only involves reasoning but contains a distinct implication of priority of the problem situation over the statement of principles. The learner in the *project method* is brought face to face with the difficulty and in the process of dissolving this difficulty or arriving at a solution, principles are developed as needed. The skill in teaching is brought into play just here—in staging situations which present difficulties and arouse in the minds of the learners a need for solutions.

(4) The implication of the term, natural setting, has been discussed in the beginning of this paper and it is unnecessary here to go into detail other than to state that the project provides for the natural setting of situations, which means that the situations undertaken in school are not essentially different because they are problems taken up in school from what they would be were they to come up in life outside the school.

The situations which were proposed in connection with the study of household science and agriculture are adequately taken care of by the concept project as here defined and described.

The boy who controlled at least one pen of poultry, with facilities for feeding a balanced ration and trap nesting individual birds for comparison of productivity in laying, would be brought into a situation which demands reasoning. The memory of information would not be sufficient to carry on this problem, for the conditions

as they change daily demand reasoning. The results of his investigation and the principles which would be evolved as needed would result in the completion of the act in its natural setting. If the boy had become interested in the *project,* had started it, but after a few days or weeks had stopped, no results of any consequence would have resulted and it would have illustrated a situation, arising in its natural setting, but not carried to completion. This could be designated as an incomplete *project.*

THE NEED OF THE CONCEPT PROJECT FOR CERTAIN TYPES OF TEACHING SITUATIONS.

Situations, such as the foregoing, have been recognized for a long time by educators as a type of educational problem which is worthy of solution, even though it has seemed difficult to devise a teaching unit which would handle such a situation. The recognition of the need for such a concept, has led to discussion of the *project* with concurrent definitions which vary more or less in inclusiveness, yet which indicate a search for a concept such as proposed.

DEFINITIONS OF PROJECT PROPOSED BY TEACHERS OF SCIENCE.

The *project* has been developed and used rather extensively by teachers of science, yet very few definitions have appeared and even these probably could better be termed characterizations.

The most comprehensive characterization has been given by C. R. Mann:

"(1) A desire to understand the meaning and use of some fact, phenomenon, or experience. This leads to questions and problems. (2) A conviction that it is worth while and possible to secure an understanding of the thing in question. This causes one to work with an impelling interest. (3) The gathering from experience, books and experiments of the needed information, and the application of this information to answer the question in hand."[9]

A few citations from the writings of J. F. Woodhull will give his views of the *project method* in science.

"The purpose of science teaching in all grades of schools is not chiefly to impart knowledge of subject matter but to train persons in the method of the masters, which is invariably the project

[9] Woodhull, John F. The Aims and Methods of Science Teaching. General Science Quarterly, Vol. 2, pp. 249-250, Nov. 1917.

method. This is the method used by intelligent men in achieving their ends, in school or out."[10] In commenting on the method of the masters this reference will be explanatory: "The real way to learn fundamental principles is to attack those problems of which life is full for each individual, not through the preparatory fallacy called the scientific method, but by a 'forked road situation.' The school should prepare pupils to walk alone by attacking real problems as Archimedes, Galileo, Davy, Faraday, Pasteur, Tyndall, and all the rest did. Most of us know, if we would think back over our experiences, that we never really learn these so-called fundamental principles until they come to us as an interpretation of some of our life's problems."[11]

Woodhull indicates that the *project method* is nothing more or less than the method of the scientist adapted to children. In order to get a more accurate notion of Woodhull's conception of the *project* it is necessary to determine just what is the method of the scientist. Morris Meister of Columbia University gives the following analysis of the scientist at work:

"(1) That he begins in a state of perplexity.

"(2) That he works with an intense enthusiasm because this perplexity is the result of a real, pressing, vital difficulty.

"(3) Once the difficulty is clearly defined his enthusiasm carries him to a solution by a process which is automatic but which can be described as:

"(a) A process of rapid suggestion, supposition, guess, hypothesis or theory—pending further evidence.

"(b) 'Reasoning out' the implications of each suggestion.

"(c) Deliberately and cleverly arranging conditions in accord with the requirements of any of the suggestions to see what results occur and to weed out the false suggestions."[12]

"*A project,* or *problem,* differs from and is superior to a topic in that (1) *a project* originates in some question, and not in such a logical sequence of ideas as may be found in codified subject matter. In teaching from the so-called 'logical' texts one wrongly attempts to induce pupils to accept topics as their own *projects.* Local organization of such material as functions in life will be the final result of a protracted study of *projects.* (2) The *project* involves

[10] Woodhull, John F. The Aims and Methods of Science Teaching, General Science Quarterly, Vol. 2, p. 249, Nov. 1917.
[11] Woodhull, John F. Science Teaching by Projects. School Science and Mathematics, Vol. 15, p. 229, 1915.
[12] Meister, Morris. The Method of Scientists. School and Mathematics. Vol. 18, p. 743.

the active and motivated participation of the pupil in carrying it out. It does not, therefore, like the topic, lend itself to didactic, formal treatment in which the teacher does all the thinking and the pupil passively absorbs. (3) *Projects* furnish a basis for the selection of facts according to value or significance; topics furnish no such basis for selection. (4) The *project* seldom ends in a complete, final or absolutely finished conclusion."[13]

Again, J. A. Drushel, science teacher in Harris Teachers College, St. Louis, Missouri, proposes this definition: "A project is a concrete problem outlined sufficiently fully and clearly to carry it out."[14]

J. A. Randall, Department of Physics, Pratt Institute, Brooklyn, New York, defined a school *project* as " a problem the solution of which results in the projection of some object or knowledge of such value to the worker as to make the labor involved seem to him worth while."[15]

The definitions proposed in the field of science agree in that the *project* involves a problematic situation, in fact, Woodhull does not differentiate between the *project* and the problem, but Randall and Woodhull alone lay emphasis on carrying the act to completion. Randall makes no provision for the natural setting of the problem. The situation outlined by Mann and Woodhull may be properly classed as a multi-problem, by Drushel an application, while Randall's definition covers most of the elements which have been considered essential to the project, with the exception that the natural setting for the problem is not specifically indicated.

IMPLICATIONS OF THE PROJECT.

The definition of the *project* takes into account the natural setting of the problematic act which means that it has significance for the learner. The natural setting provides a strong motive—testing seed corn for the father is more interesting than making laboratory tests of one or two ears of corn. All *projects* may not be interesting to any one student, but interest in the projects selected by the pupil is likely to be very high. When a project is interesting it is very interesting. The *project* creates interest of a deep-seated sort because the interest comes from associative connections of many

[13] Woodhull, John F. The Aims and Methods of Science Teaching. General Science Quarterly, Vol. 2, p. 250, Nov. 1917.
[14] Drushel, J. A. Definition sent to writer by Superintendent John W. Withers. St. Louis, Missouri, March 23, 1918.
[15] Randall, J. A. Project Teaching, N. E. A. Report, p. 1010, 1915.

sources. The *project* offers many more reservoirs from which interest may be drawn.

If the *project* is to be made the basis for the curriculum it is necessary to decide what principles should be mastered by the students and then select *projects* or groups of *projects* from which the students may select. The *projects* selected by the pupils will be such that all the facts, principles, and processes will be covered which ordinarily are covered in the logical or systematic presentation.

After the facts, principles and processes have been covered by the *project method* in class, enough time should be left in the course so that the subject matter may be systematized. First, the *project* is used for the approach to all parts of the subject, and then a systematizing study of the field follows as an extended summary.

The shortcomings of the *project method* are in not making adequate provision for habits and skills and for giving a systematic or logical view of the subject. A methodology which makes no provision for these other than in a purely incidental way, is seriously defective and may greatly make its theory subject to the criticism, that it is encouraging "soft pedagogy."

The use of the *project* in science teaching is not always in good repute, not due to any inherent fault of the method, but due rather to the fact that the method is rarely carried to completion. As Bobbitt suggests: "It is by far the most complicated method; and differs most from familiar traditional ones. It is not, therefore, surprising that teachers often develop an incomplete and ineffective form of the method. Whenever a training task involves practical performance, this is so visible, tangible, and solid sense that it often comes to be conceived as being the whole thing. The teacher attempts to get the pupils in the most economical and expeditious way to perform the practical actions by way of securing the results. The teachers, therefore, often do the thinking, draw up the plans, and prescribe procedure for the students."[16] Such a procedure, of course, is not the spirit of the project method and rightfully deserves such characterization as a "hodge-podge" science, "soft pedagogy," an "unorganized mass," "a device for getting hold of deficient students and keeping them from making trouble or from leaving school."

[16] Bobbitt, F. The Curriculum, pp. 31-32. (Houghton, Mifflin and Company, Chicago.)

The *project method* rightly carried on develops great interest, gives training in carrying acts to completion, and provides adequate opportunity for directing thinking and reasoning. Its shortcomings are in providing for habit formation and a systematic view of subject matter.

At the close of this paper the question of practical applications of the general fundamental facts brought out in it was raised. Dr. Stevenson, in reply, expressed his willingness to cooperate in assembling data on tried projects in the various science courses. A motion was presented authorizing the Chair to appoint a representative committee from the science groups of the Conference to cooperate in assembling data on the Project Method of Science Instruction. The following constitute the membership of this committee: Dr. J. A. Stevenson (Chairman), Urbana; Dr. H. D. Waggoner, Macomb; Miss Florence Churton, Urbana; Mr. T. M. Barger, Normal; Miss Annie L. Weller, Charleston; Mr. Carl Colvin, Urbana.

Guiding and Aiding the Pupil in His Project

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The most common criticism of the use of projects in science teaching or of teaching by projects in general, is that freedom when given to the immature so easily turns to license. The criticism becomes a weighty one when we consider the fact that most of the unsuccessful attempts to teach by projects are due to the inability of the teacher to control either the course of study, the sequence of recitation units or the class itself. It is my feeling that just as in life, and especially in a democratic life, the highest kind of freedom of the individual is built upon a system of controls and restrictions—so in a project there must be definite place for guidance and control. All his life the individual is interfered with in a hundred different ways so that he may establish habits which will set free his powers for greater and finer tasks. It is a mistake to think that in a project all that the teacher does is to get out of the way. As in life so in a project there is just as great need of guiding the child through the experience (project), if he is to live through it successfully.

And to live through an experience successfully is, in the learning process, just as important as the interest with which a pupil

approaches a situation. Failure and repeated failure will not only tend to destroy healthy interest, but will create an attitude and habit of discouragement toward problems in the future. Success and repeated success on the other hand will stimulate interest to greater effort and will tend to make whatever results there are permanent. Of course it is easily possible to carry these "guides" and "controls" to an extreme, rob the pupil of initiative, make impossible concentration of effort, and in general make things too "soft" for the pupil. It has been my experience however that this is not at all the danger in project work. Starting with a genuine, wholehearted interest, tendency is ever so much greater that the child will strike a snag, meet with an insurmountable difficulty and become discouraged.

The discussion which follows is based on several years' experience with project teaching at the Speyer and Horace Mann Schools of Teachers College and aims to point out some of the tools at the teacher's disposal:

(a) for inspiring the pupil.
(b) for stimulating him to effort.
(c) for removing the insuperable difficulties.
(d) for guiding him to possible solutions.
(e) for assisting him in cooperative effort.
(f) for keeping track of and controlling in a general way his activities.

A. THE LIBRARY OF BOOKS.

From time to time, in this and other periodicals, lists of books and references for General Science classes are printed. Of the three or four hundred I have seen mentioned, I have been able to inspect about two hundred; and of these about sixty or seventy seem to be of most value as sources of information and inspiration, on a great variety of scientific topics. It is very probable that the number can be reduced to about thirty or forty; and if General Science teachers would cooperate in this matter we might determine a "minimum shelf" of reference books for General Science. It would be of great interest and value to compare the list here given with similar lists gotten up by other teachers.

THE LIST OF REFERENCE BOOKS.

BOOK	AUTHOR	PUBLISHER
Book of Knowledge,		The Grolier Society
Book of Wonders,		Presbrey Syndicate, Inc.
Wonders of Science in Modern Life,	Williams .	Funk & Wagnalls
Wonder Book of Light,	E. J. Houston,	F. A. Stokes & Co.
Wonder Book of Volcanoes and Earthquakes,	E. J. Houston,	F. A. Stokes & Co.
Wonder Book of the Atmosphere,	E. J. Houston,	F. A. Stokes & Co.
Wonder Book of Magnetism,	E. J. Houston, ..	F. A. Stokes & Co.
Automobiles,	J. S. Zerbe,	Cupples & Leon Co.
Motors,	J. S. Zerbe,	Cupples & Leon Co.
How It Works,	A. Williams,	T. Nelson & Sons
How It Is Made,	A. Williams,	T. Nelson & Sons
How It Is Done,	A. Williams,	T. Nelson & Sons
Books on General Science: Hodgdon, Barber, Caldwell, Clarke, Hessler, Pease, Snyder, Fall, etc.		
Harpers Electricity Book for Boys,	J. H. Adams, ..	Harper Bros.
Harpers Machinery Book for Boys,	J. H. Adams, ..	Harper Bros.
Romance of Aeronautics, ...	and others .	
Romance of Submarine Engineering	of the	
Romance of Modern Electricity, ...	Romance ..	
Romance of Astronomy, ...	Series	Lippincott & Co.
Boys' Book of New Inventions,	H. E. Maule, ..	Doubleday Page
Boys' Book of Modern Marvels,	C. J. L. Clarke,	F. A. Stokes Co.
Boys' Play Book of Science,	J. H. Pepper, ..	E. P. Dutton & Co.
All About Engines,	E. Cressy,	Funk & Wagnalls
All About Aircraft,	R. Simmonds,	Funk & Wagnalls
All About Railways,	F. S. Hartwell,	Funk & Wagnalls
All About Engineering,	G. D. Knox,	Funk & Wagnalls
All About Ships,	T. Darling,	Funk & Wagnalls
All About Electricity,	G. D. Knox,	Funk & Wagnalls
Electricity and Its Everyday Uses,	J. F. Woodhull,	Doubleday Page
Story of the Submarine,	F. Bishop,	Century Co.
Submarines,	F. A. Talbot,	Heinemann

Moving Pictures, F. A. Talbot, ... Heinemann
Modern Chemistry and Its Wonders, Martin, ... Heinemann
Chemistry for Young People, T. Juels, ... Heinemann
Boys' First Book of Inventions, Baker, .. McClure Phillips & Co.
Boys' Second Book of Inventions, Baker, McClure Phillips & Co.
Weather and Weather Instruments, Jameson, .. Taylor Inst. Co.
Chemistry of Common Things, Brownlee, ... Allyn Bacon
The Boy Electrician, D. Morgan, ... Allyn Bacon
The Boy Mechanic, ... Popular Mechanics Co.
The Boy Scout Manuals,
The Handicraft Series (20 vol.), P. N. Hasluck, Funk & Wagnalls
Book of the Ocean, E. Ingersoll, ... Century Co.
World of the Great Forest, P. Du Chaillu, ... Scribners
Flowers Every Child Should Know, F. W. Stack, Doubleday Page
Trees Every Child Should Know, J. E. Rogers, Doubleday Page
Birds Every Child Should Know, N. Blanchan, Doubleday Page
Amateur Aquarist, M. Samuel, ... Baker & Taylor Co.
Our Insect Friends and Foes, B. S. Cragin, ... Putnam
Story of Great Inventions, E. E. Burns, ... Harper & Bros.
Stories of Invention, R. Doubleday, ... Doubleday Page
Famous Men of Science, S. K. Bolton, ... T. V. Crowell & Co.

B. THE CARD INDEX.

The above and other references have been indexed by the pupils according to projects. Each project has its own card (or cards) and on it are the following types of information:

(a) The books in which information can be found.
(b) Other possible references.
(c) Brief suggestions as to how to "go about" the project.
(d) Some simple experiments that can be performed and directions as to where apparatus can be obtained.

There is a pupil librarian in charge of this index; but each boy is expected to add to his project card in payment for the help he has received from those who have gone before him. This of course can not be followed too closely or persistently but it gives a very valuable opportunity for cooperative effort. As time goes on this index becomes a more and more valuable instrument for guidance and assistance.

C. THE CONFERENCE WITH THE TEACHER.

Probably the greatest opportunity which the individual project

offers in an educative way is the opportunity for personal contact between teacher and pupil. In a five minute conference with a pupil I find it possible to get him to tell me what he wants to find out, or to do, or to learn; to suggest if he needs it a method of attack and to answer if possible and advisable any troublesome questions he may have. At a later conference, he reports his progress, sometimes in the form of an outline, and is helped to organize his material and to frame a set of questions embodying the essential points. These questions the class is to answer after listening to his report. The amount of help it is necessary to give depends entirely upon the age of the pupil and upon his ability. For each class of twenty-five, habituated to such procedure the teacher may find it necessary to give from one half to three-quarters of an hour a week for conferences. The pupils must be encouraged to come and yet there must be the understanding, that the purpose is not primarily to be helped but to consult with the teacher and to show him what he has already done. The teacher plays the part of "expert" and confident. He must listen sympathetically and helpfully to the numerous "schemes" and "inventions" and new ways to make this or that "go." As a rule the pupils talk to you unhesitatingly and at length. They are not very anxious to listen to you unless they ask a question. They are seeking the chance to express those thoughts which parents are so often incapable of appreciating and which friends too often laugh at. If the teacher can therefore step in and assume these functions of parent and friend he not only opens up for himself the greatest joy a teacher can have but paves the way for real progress and knowledge.

D. THE SETS OF QUESTIONS.

There is available a collection of sets of questions which boys in the past have gotten up in connection with similar projects. The number of these is steadily increasing and serve as models for the weaker members of the class.

E. THE LISTS OF EXPERIMENTS EASILY PERFORMED.

It is most surprising how original boys can be in thinking up ways to illustrate ideas. There are dozens of little "stunts" that they like to pass on to each other. The librarian keeps them in an available form. The Card Index aims to direct the boys to these experiments for each project.

F. THE MAGAZINE, NEWSPAPER AND PAMPHLET COLLECTION.
These are indexed by the boys and form part of the library. And in addition there is kept a list of firms, etc. which will send free or for a nominal charge certain pamphlets, specimens, etc. or loan slides, charts or other illustrative material. One of the obsessions for a boy is to correspond. Why not use this instinct for educative purposes?

G. THE LABORATORY.
To try out some experiment, to learn the workings of some mechanism or to construct some piece of apparatus, the school shop is used as a laboratory. The boys are organized into a club which has as one of its purposes, "to help its members in the solving of their problems." Among other things this club possesses a collection of "Chemical Sets" and "Structo Outfits" which are available for experiment.

H. INSTRUCTIONS FOR LECTURERS.
In preparing for his report the following is put before the pupil:

(1) What is my subject?
(2) What are the 3, 4, or 5 important facts I wish to tell the class?
(3) What is the best order in which to present them?
(4) Under each of my big topics what are the details I plan to give?
(5) Omit the unimportant details.
(6) Are there any ideas I can explain better by means of a diagram?
(7) Can I get pictures, specimens or pamphlets to illustrate?
(8) Can I profitably use lantern slides? Can I get them?
(9) Are there any ideas I can explain better by means of an experiment?
(10) If so how long will the experiment take?
(11) Can you get the apparatus and can you work it before the class?

Remember That

(1) In one period you can not tell all you know about your subject.
(2) The boys in your class have not studied the subject yet.

(3) The boys must be made ready to understand what you say.
(4) Everything you say must have some bearing on what you are trying to explain.
(5) If you have any conclusions you must drive them home by making clear to everybody what they are.
(6) You must watch the clock as you speak.
(7) Your classmates have no right to side-track you on other subjects.
(8) Your classmates have a right to ask you about things which are "in order."
(9) Your questions must be clear and definite.
(10) If you don't finish on time it is your own fault.

I. THE CRITICISM.

After each report the class spends a few minutes discussing the presentation from the following viewpoints:

(a) Preparation.
(b) Knowledge.
(c) Interest of presentation.
(d) Organization of material.

J. KEEPING THE CLASS AT WORK.

To keep track of the class as a whole (or rather of the indifferent individuals) a few minutes may now and then be spent in having the class answer some such questionnaire:

(a) What reading have you already done on your subject?
(b) State three facts which you have already learned.
(c) What else have you already done?
(d) What is the hardest thing about your project? etc., etc.

Carelessness + Thoughtlessness = Accidents
Carelessness + Neatness = Safety—*Safety News.*

"What did de white folks put Brudder Smugg in jail fer?"

"Trigonometry, sah. He done had three wives."—*Inland Steel Bul.*

Studies of the Masters

II. Scientific Orthodoxy.

By John F. Woodhull.

If the word "orthodoxy" had its original meaning (correct thinking) the two words *scientific orthodoxy* would not appear so incongruous. But by usage the word *orthodox* has come to designate, not one who thinks correctly, but one who does not think at all; one who rests upon the authority of someone else; one who follows a leader; one who is a sheep. With this idea of orthodoxy we would fain think that everything scientific is at variance.

The history of science however, shows that orthodoxy is quite as prevalent among scientists as among theologians, or artists, or musicians.

Galileo's bitterest enemies were his associates in Science upon the faculty of the university of Pisa. With them orthodoxy meant following Aristotle. They rested so completely upon his authority that they not only thought that whatever Aristotle said must be true, but also, if he did not say a thing it could not be true. To such persons Galileo was a dangerous heretic because he proposed to test some of the conclusions of Aristotle. For example, when Galileo proposed to drop two weights from the top of the leaning tower of Pisa to test the doctrine of Aristotle that the heavier one would fall faster than the light one, the orthodox were violently opposed to having any facts brought to light which might discredit Aristotle and jeopardize their own prestige.

Even before the days of Aristotle it had been proven that the earth revolves around the sun. But Aristotle, who was wise in most respects, chose in this matter to be foolish, and maintained that the sun revolved about the earth. Copernicus, Galileo and others preferred to be right than to be orthodox and determined to let a truth which had been established for two thousand years shine into the world through them. For this "sin of unbelief" in Aristotle, Copernicus escaped burning at the stake only by dying prematurely and Galileo suffered worse than death.

In the year that Galileo died Isaac Newton was born, and became

in due time a great master in Science. The greatest men have streaks of smallness and the wisest men have streaks of folly. In the face of evidence, sufficient to convince a goodly number of his contemporaries, that light was a wave motion, Newton preferred to assert that light was a stream of material particles. And throughout his whole life he clung to the "corpuscular" theory of light as against the "undulatory" theory. For a century and a half the great majority of scientists followed Newton and rested upon his authority. "There is no other instance, in the whole history of modern physics, in which the truth was so long kept down by authority." The "corpuscular" theory was orthodox. But the truth already revealed by the heterodox Huygens, Boyle, Hooke, Euler, Rumford, Young and Fresnel in time prevailed and the "undulatory" theory at length became orthodox.

Since for more than two thousand years the great mass of scientists rested upon the authority of Aristotle and Newton, it is quite proper to call such men Masters in Science.

For about one hundred years it was scientifically orthodox to believe in the "phlogistic" theory of combustion. Stahl enunciated the doctrine in 1680 and for three generations men's minds were so imbued with the idea that they were incapable of recognizing the very convincing evidence in favor of the rival theory of oxidation put forth, more or less unwittingly, by Mayow, Hooke, Boyle, Black, Cavendish, Priestly, Watt, Scheele and Lavoisier. In fact Priestly and Cavendish whose work contributed most toward the overthrow of the doctrine of phlogiston were themselves too orthodox to see the light shining through themselves, and died "true to the faith."

Priestly, almost on his deathbed, was able to write a book entitled "The Phlogiston Theory Established" twenty years after it had been completely overthrown. From which it would appear that scientific orthodoxy has in it an element of bigotry. The theory was that things lost phlogiston when they burned. But when the skeptical called attention to the fact that metals gained in weight when burned, the orthodox said phlogiston is the "principle of levity" and when it departs from a metal its weight is thereby increased. By which we are reminded that facility in exegesis is characteristic of orthodoxy.

During the first half of the nineteenth century more than

thirty "heretics" brought forward evidence of the truth of the evolutionary theory. Chief among these was Charles Darwin, who gave what is now considered a complete and all-convincing demonstration. Cuvier in France however, had opposed this doctrine. When therefore Mr. Darwin, near the close of his life, was proposed for membership in the French Academy, more than two-thirds of the members voted against him on the ground that "Mr. Darwin's writings are not science, but a mass of assertions and absolutely gratuitous hypotheses, often evidently fallacious. This kind of publication and these theories are a bad example, which a body that respects itself cannot encourage." Already Darwin had been elected to more than seventy scientific societies in every civilized country. The French Academy was largely composed of the followers of Cuvier. A very few years later the same academy elected Darwin to membership. Since meanwhile he had not changed, orthodoxy must have changed.

Among scientists as among the rest of mankind the ninety and nine follow like sheep the authority of a master. Is it altogether honest to claim that we give the Doctor's degree as a prize for original research when candidates are led to think that the best way to pass the examinations of professors is to get on to their idiosyncracies and loyally subscribe to their particular hobbies? It would appear that the great business of a university is not to spread light, but to foster and protect orthodoxy. To this end its faculties are devoted to "putting up the bars."

Fire Carelessness

In ten months of 1918, with the United States at war, the fire loss was greater by a hundred million dollars than in the corresponding period of 1916.

Fire loss is only one typical item. War has done much to popularize thrift. Never before was there such a conscious, sustained effort to save. But war has not shaken us out of our careless, wasteful habits. When we toss a cigar stub on a heap of shavings or leave an electric wire half insulated we are not thinking of thrift—or of anything else. We are just mechanically following a bad habit.

Out of ten motions in the course of a day we think of thrift only in connection with one of them. The task is to cultivate a hundred per cent. habit of thrifty thinking. Such a habit will cut the fire loss in half.

Peggy Learns that Housekeeping is Science

THURE HANSON, Commissioner of Standards for Massachusetts.

It was Peggy's first day home after school closed in June. With an exclamation of joy Peggy opened her blue eyes to her first vacation day. No more school for two months and a half! Peggy jumped out of her little cot with a great "Hurrah!"

And then suddenly she remembered the new order of affairs that was to go into effect in her home this very day! Only the night before she and her mother had planned it. Peggy was to be mother's helper this summer. And she was going to get a real salary for her work and earn money for the first time in the thirteen long years of her life.

"Hurrah!" hummed Peggy as she dressed hurriedly. Wasn't this going to be a glorious adventure! But the thought that sent her dancing merrily down to her breakfast (a trifle late for a helper—but many things are overlooked one's first day) was: no more arithmetic for a long time!

"Ready, Peggy?" asked her mother a little later, looking up from the beginnings of a loaf cake.

Peggy saluted, real military fashion. "Aye, aye, Captain Mother," she said, standing at attention in her miniature Hoover apron that her mother had made for her.

"Did you ever hear about denominate numbers?" began her mother, reaching for the flour.

Peggy nearly jumped out of her apron in surprise. "What have they got to do with cake?" she answered. "They're all about furlongs and acres and troy weights and kilometers."

"Well," said her mother, "denominate numbers are just tables for measuring things. When you keep house you discover that you can't do it properly without measuring something almost every half-hour of your day. Now this recipe calls for three cupfuls of flour,"—and she held up her half-pint measuring cup,——"five level teaspoons of baking powder,"—the set composed of whole, half and quarter teaspoons was pointed out,—"half a cupful of butter, a cupful and a half of sugar, and three eggs. These eggs are small, so I guess I'll use four. Some recipes call for a certain measure of eggs instead of numbers, and it's much more accurate. When you measure everything your cake always comes out the same."

"Any other measurements required?" asked Peggy, beginning to be interested in spite of the denominate numbers.

"Two more," said her mother; "the oven temperature and the time. This recipe says: 'Bake forty minutes at a temperature of 240 degrees.'"

Peggy wandered over to the stove and inspected the dial on the oven door. Then catching sight of the thermometer hanging on the pantry door, she studied it carefully. "Eighty-five degrees," she said.

"Don't you know what the temperature of a room should be, Peggy?" asked her mother. "It should be 70 degrees for a room where people are sitting, but 55 degrees in our bedrooms when we are out of them. Better run upstairs and take the temperature of each room. Open the windows in the bedrooms."

When Peggy returned from her first official inspection she found her mother in the cellar superintending the delivery of coal. While waiting, her mother directed Peggy to take the readings of the gas and the electric meters. "Later on," her mother said, "we'll compare them with the readings on the last bill. This helps us to find out whether the company is to blame for high bills or whether we've just been careless."

Then, after leveling the coal in the bin, her mother took her steel tape and measured the height of the pile. "Two and one-half

feet," she wrote upon a slip of paper. "Now you will notice that the bin is exactly rectangular in shape. Its inside length is six and a half feet and the width four feet, so I will multiply the height by the length and multiply the result by the width, which shows the volume of the coal to be sixty-five cubic feet.

"Fifty-seven pounds to a cubic foot of white ash coal, egg size," she went on aloud. "A ton is 2,000 pounds, you know, Peggy; so the answer should be 4,000 pounds of coal."

"Peggy busied herself for a moment with pencil and paper. "But it isn't," she cried excitedly. "Sixty-five times fifty-seven is three thousand seven hundred and five; so it's short weight by two hundred and ninety-five pounds."

The coal man, listening, blushed under his grimy mask. "I'll make it good," he muttered as he left.

"He's probably got the rest of it under his wagon seat," said Peggy's mother. "There are tricks to every trade, dear, and a good housekeeper has to know how to check every one of them."

Peggy laughed. "And I thought housekeeping was just sweeping and washing dishes and cooking."

Back in the kitchen Peggy began to put things in their place. "Put the butter on the shelf just under the ice," her mother called out, "that's the coldest spot. And the eggs go at the bottom. Meat and milk and butter develop bacteria faster than any other foods and must be kept as cold as possible."

"Why don't you wrap your ice in newspaper, the way Auntie does?" asked Peggy. "Doesn't it save ice?"

"Auntie and I differ on that point. You see the temperature of the refrigerator is lowered by the melting of the ice. Wrapping the ice is a good way to save it but a poor way to save food. The way to find out the coldest spot is to measure by the thermometer, of course."

Just then the grocer boy appeared with the day's order. "Where's the slip?" asked Peggy's mother. "I always require it to check up what I buy." Then she weighed each purchase on her scale. For cheese weighing a pound they had charged her 25 cents instead of 22 cents. "That comes from so many people ordering by the 25-cents' worth or by the piece instead of by specific weight," she said. Then she weighed the beef and the bag of trimmings that she always insisted on having sent home for soup. Together they weighed just six pounds. She had bought and paid for seven and a quarter that very morning. "I'll have to go down town and teach that grocer a lesson, Peggy," she said. "I'll go now and straighten out this affair.

"While I'm gone, Peggy," she added, "get out the scales and check up the potatoes and the apples. I bought a peck of each. The potatoes should weigh 15 pounds and the apples 12 pounds.

"You may also examine the kerosene can and see if a full gallon was delivered."

"Why," cried Peggy, looking into the top of the can, "it must be short measure, because this is a gallon can and it isn't filled to the top."

"But you mustn't jump at conclusions, Peggy," replied her mother. "Kerosene expands considerably in a warm temperature, and an oil can is usually made so that its actual capacity is at least three per cent greater than the quantity which it is expected to contain, so as to prevent the oil from overflowing. You should remember that the oil can is intended to be used as a container and not as a measure."

"Then how can I tell whether it contains a full gallon?" asked Peggy, somewhat petulantly. "Must I empty the oil into a gallon measure?"

"No, I think not," and her mother produced a round pencil-shaped stick about fifteen inches long, "for I have prepared this

gauge by which we may find very nearly the actual quantity. You will notice that I have carefully traced thirty-two lines, or graduation marks, upon it. The four lines which completely encircle the gauge stick show the height of each quart of oil in the can. The four which extend only half way round measure the intermediate pints, while the spaces between these are in turn divided by shorter lines, each representing one gill. Now I will push the gauge gently into the can until it rests upon the bottom, and then immediately withdraw it," and she suited the action to her words. "You see that the oil now shows quite up to the gallon mark on the gauge, so the quantity is substantially correct. I prepared this gauge for this particular can, and of course it could not be used upon any other without first determining the accuracy of the graduation marks as applied to the other can."

"Whew!" exclaimed Peggy, "a housekeeper has to keep track of every little thing she buys, doesn't she? Housekeeping is like a business, isn't it?"

"Exactly, my dear. It's the most important business a woman can learn. The woman's part is spending her husband's money wisely, getting full value for every penny paid out."

Left to herself Peggy began a systematic seach for every kind of measure in the house. With pencil and paper she made out a list. In the kitchen she noted the set of measures, the clock, the room and oven thermometers and the scales. In the pantry she found a glass graduate which came in handy for measuring small quantities of liquids to go into other receptacles. She found thermometers everywhere. Now indeed she knew what her mother meant when she declared that she was going to get the maximum heat out of her coal.

In the bathroom Peggy found a thermometer for baby's bath. There was the little one, the "clinical" one, to be used when any one was ill. Then there was the letter scale on mother's desk, to save on postage, and her own school ruler. And there was father's folding two-foot rule, and of course the tape measure in the sewing machine.

"Gracious," sighed Peggy. "All this is housekeeping. How ever did mother find it all out?"

But Peggy's mother knew, as do all good housekeepers, that their knowledge comes from many sources, some even from arithmetic and other sciences, all applied to the affairs of life in the home.

Housekeeping today is a science, Peggy learned. She learned, too, that the State has never lost interest in furnishing this knowledge to and for its housekeepers, and that in the State House, in the Department of Weights and Measures, all this information has been put together in bulletins. These are within reach of all the Peggys and mothers who care to send for them. And there are wise words and helpful hints contained in the pamphlets which may be obtained by sending four cents to cover the cost of postage. Wise housekeepers will do well to avail themselves of infinite opportunities to perfect the science of household efficiency offered to them.

Junior High School and High School Science

The following resolution was unanimously adopted by the Science Sections of the Illinois High School Conference at a meeting held in November, 1918.

Whereas, a more efficient and more extensive general education in science is highly necessary in the interests of social welfare, and

Whereas, under the present chatotic condition of science instruction, especially in the first two years of the high school, such instruction seems to be losing ground, instead of gaining, notwithstanding the rapidly increasing need for training in science, as the problems of society grow more complex, and the rapidly increasing ability of science to meet these social needs, and

Whereas, it is obvious that the present unsatisfactory condition of science instruction, and the decline of science studies in popular favor, is due, not in the least degree, to any discovered inherent faults of science itself, as educational material, but rather wholly due to certain external conditions and tendencies, which have grown up more or less fortuitously, in recent years; such as the tendency to multiply the number of slightly different types of science available for high school instruction; the tendency of science teachers to divide themselves into small groups, each devoted to the interests of some narrow branch of science, or special type of science, or method of organizing science, and to advocate these to the utter neglect of other equally important parts or phases of science education; and finally the tendency toward complete free election of

science studies which leaves to the caprice of the high school pupils the important question as to whether or not he shall study any science.

These tendencies have almost completely destroyed all united effort in support of the common interests of science instruction, and thru the turmoil and conflict that they have led to, have destroyed the confidence of non-scientific people in the educational value of science. We can correct this condition, only by uniting solidly behind some definite, sane and workable program for science instruction.

Therefore, be it resolved, by the Science Sections of the Illinois High School Conference, in joint session assembled,

That we pledge our united support to the following program for science instruction in the high school:

First: Two full year-courses, in what shall be essentially fundamental science. This work to be given in the first two years of the high school, or where junior high schools exist, the same work may be done, in the eighth and ninth grades or spread over the seventh, eighth, and ninth grades. This work, which is intended as the common pabulum of scientific knowledge, should be required of all students in so far as it is administratively possible.

Second: As many full year courses in the applied sciences, and in the special science, should be given in the later years of the high school course as there is demand for, and as the size of the faculty and equipment will permit. These latter courses, unless it be in the case of agriculture and home economies for certain groups of students, should be purely elective, and should be so organized and taught that each year course may answer as the equivalent of a first semester course in the subject in college.

As an outgrowth of the discussion of the papers presented at this session the Chair appointed a committee whose duty shall be that of presenting to a later meeting of the science groups recommendation concerning the content of such a two year science course as is suggested in the resolution. The following constitute the membership of this committee: J. L. Pricer (Chairman), Normal; A. W. Nolan, Urbana; J. W. Shepard, Chicago Normal College; Miss Florence Harrison, Urbana; Miss Mable Stark, DeKalb; Raymond W. Osborne, Francis W. Parker School, Chicago; John P. Gilbert, Carbondale.

Science Instruction in England[1]

Sir H. H. Johnston, G. C. M. G., K. C. B.

We drifted into this war through sheer lack of expert knowledge of foreign countries and foreign language. We have muddled and misconducted our war operations on sea and land through expert knowledge of science on the part of those commanding at home and sometimes—happily, not always—of those commanding abroad.

Prior to the war, because of our contempt of scientific education, we offered little or no inducement to our young men and women to serve the Home Country and the Empire in the application of science to industry, commerce and the enlargement of the national intelligence.

Now we require not only to train British biologists, astronomers, ethnologists, philologists, historians, chemists, and a hundred other diverse types of specialists, but equally we need to give a glimmer, a *general idea* of these branches of science to all the people of the realm.

Education it seems to me, comes under three heads:

(1) That which deals with the necessities of man's body—gymnastics, training the eye and ear, the development of muscles, skill with weapons or utensils, the strengthening of the nerves, the making of each girl and boy into as healthy and fit a member of the community as possible. The teaching of all the mechanical and construction arts that go to feeding our bodies and minds, sheltering us, transporting us from place to place, and clothing us.

(2) That which supplies the requirements of man's mind, all useful learning regarding the past, the place of our planet in the Cosmos, the other forms of life that share the earth with man, the interpretation of the great New Bible—in short the Book of the Earth—itself.

(3) That of the education of the soul. Into this third great branch of education science, founded upon demonstrable truth,

[1] Extract from Address given before Association of Public School Science Masters.

must enter; suposition must be banned. The scientific bases and authority for temperance and chastity must be explained; children must be shown that wrong doing against one's self or the community does not pay in the long run—that against one's own body and mind is rapidly punished; that against the community not only are there unpleasant consequences through the enforcement of laws which we have made for the protection of the community, but also that the wrong-doer himself would suffer in security and happiness were there no such laws.

How to Use the Kitchen Range

Linwood L. Workman, Framingham Normal School.

One of the lessons which I repeat each year in my general science classes is The Kitchen Range. We had that project the other week and "for the fun of it" I asked for certain data from the ninety-seven young women who were in class on that day. You will perhaps receive the same surprise that I did when you read that of these high school graduates, representing a comparatively large proportion of the state, coming from good schools and representative homes, only 54 per cent. would go on record as being able to rise in the morning, *make a fire in the kitchen range* and take charge of things in the home! In the ninety-seven homes represented the kitchen range is being used habitually by all but four. Of the remaining 46 per cent. of young women fourteen could take charge of things provided somebody else would manage the fire.

To me this condition seems absolutely unwarranted and wrong. To be sure, there is evidenced a neglect in fundamental training in the homes, but there is also indicated a neglect in the teaching of fundamental lessons by general science teachers. It seems to me that any general science teacher who omits The Kitchen Range from his or her list of projects is neglecting a vital opportunity and together with careless parents is not meeting certain obligations to "the coming generation."

I wish to submit to general science teachers the following outline on "How to Use a Kitchen Range." It is reprinted from the Household Arts Manual prepared for The Board of Education by

a committee of which I had the honor of being a member. You may not prefer the form of outline. That is immaterial if only there will come from it an inspiration to add some *home projects* to your list of lessons in general science. In case there is no range available in your school have the lesson worked out at home.

How to Use the Kitchen Range.

(Demonstration—School and Working Project—Home.)

Aims.—To have the pupils learn by observation and practice how to build and maintain a fire in the kitchen range; how to regulate the dampers for varying the fire and heating the oven; and how to care for the stove.

Supplies and Materials.—The school range, waste papers, kindlings, coal, a candle or twisted papers, matches, blacking or paraffin oil, woolen or flannelette cloths, metal cleaner, cotton waste or soft cloth.

Suggestions to Teachers.—Use the range in the school kitchen for examination and demonstration. Assign pupils to manage the fire under careful supervision. Arrange for the pupils to manage, or to assist in managing, the fire in the range at home for a stated period.

Guiding Questions for Planning and Developing this Project.

1. What are the essential conditions for continued burning?
    1. Place a short lighted candle upon a piece of cardboard or in a pan. Cover it with a narrow lamp chimney. Note results.
    2. Relight the candle and place on either side of it a flat piece of wood one-half inch thick and about two inches long. Cover with the chimney letting it rest upon the strips of wood, then cover top of chimney with a piece of cardboard. Note results.
    3. Proceed as in 2, but leave the top of the chimney uncovered. Note results and explain all that has happened.

2. How is the range constructed?
   1. Locate, learn the purposes of and name the different parts.
   A. Remove the lids and examine the fire box.
      (1) How is the grate made?
      (2) Manipulate it as if dumping the ashes.
      (3) Examine the fire lining.
         (*a*) Why is this kind of material used?
         (*b*) Note how it is put into place.
      (4) What do you find in the space under the grate?
         (*a*) What is this space called?
      (5) Find the adjustable damper opening into the space under the grate.
         (*a*) What is it for? Name the damper.
      (6) Find the adjustable damper opening into the fire box above the level of the fire.
         (*a*) What purposes does it serve? Name the damper.
   B. Examine the parts of the stove adjoining the stove pipe.
      (1) What is the purpose of the stove pipe?
      (2) Note the movable slide or equivalent arrangement directly under the pipe. What is it for?
         (*a*) Do you find a damper farther up in the pipe? If so, explain its use and name it.
      (3) Manipulate the damper between the stove pipe and the space under the lids.
         (*a*) What is the purpose of this damper? Name it.
   C. Trace the passage leading from under the lids down at the back end of the stove and under the oven.
      (1) What is the purpose of this passage?
      (2) Do you find any partitions in it?
         (*a*) If so, what are they for?
      (3) What is the purpose of the opening, the cover of which you removed in order to see under the oven floor?

3. How do the air drafts travel in the stove and how are they regulated?
   1. By means of a lighted candle or twisted paper test the direction of air drafts under the following conditions:

(*a*) Front or creative damper open, check damper closed, oven and chimney dampers open.

(*b*) Creative damper closed, check and other dampers open.

(*c*) Creative damper open, check and oven dampers closed, chimney damper open.

(*d*) Creative damper closed, check damper open, oven damper closed, chimney damper open.

2. State the purposes of the above arrangements.

4. How shall the fire be laid?
   1. Have fire box, ash pan and passage free from ashes and soot.
   2. Arrange dampers for a "direct" draft to the chimney.
   3. Place a generous layer of crumpled paper or shavings in the bottom of the fire box; fill the fire box about half full of loosely placed kindling wood or charcoal, taking care that the ends of the fire box are well filled; cover the wood with a small quantity of coal (about half a hodful) replace the lids and brush the dust from the surface of the stove and floor.

5. How shall the stove be cleaned, blackened and polished?
   1. Clean any nickeled parts with a good metal cleanser.
   2. Apply stove polish according to the direction on the box or can.
   3. If oil rather than blacking is preferred, use paraffin oil, applying it with soft cloth or cotton waste; take up any excess oil with fresh cloth or waste; polish with a woolen cloth or flannelette.

      CAUTION.—*Never use oil on a stove when the fire is burning.* Why not? *Cautiously burn the cloths immediately after using them, taking care to see that the chimney damper is wide open.* Why?

6. How maintain the fire and heat the oven?
   1. Light the kindling, and after the coal is well fired put in any additional amount needed, not exceeding two-thirds

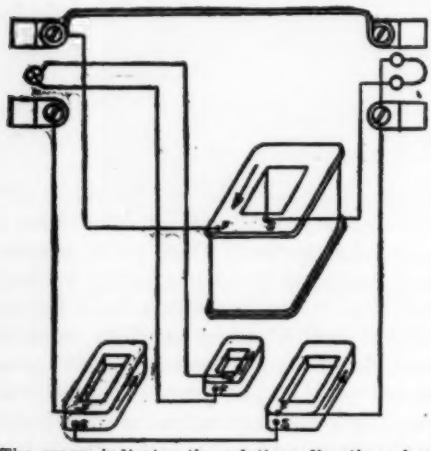
of the fire box in height. When this is burning well, regulate the dampers for "indirect" draft around the oven. Adjust the creative, check and chimney dampers to produce the desired effect.

2. Keep the fire box, ash pit and passages free from an accumulation of ashes and soot. "Keep a clean, thin fire rather than a thick, dirty one."

Principle of the Electric Watthour Meter

E. L. BROWN, GENERAL ELECTRIC CO.

The electric meter so familiar to us all thru our interest in it as a measuring device for the lighting of our homes, is really an induction motor. The disk that turns around and drives the gearing that shows how much energy (electrical) has passed thru the meter is like the motor of the induction motor.



The arrow indicates the relative direction of current flow at any given instant and not, of course, the continuous direction of flow.

In the accompaning diagram, the parts essential to the principle mentioned are the large coil (many turns of fine wire) called the potential coil and the two smaller coils (few turns of larger wire) called current coils. The small coil (short circuited on itself shown between the two current coils is necessary for accurate registration of the meter when the energy (electrical) is being furnished to motors.

Between the large coil and the two smaller coils is the disk (not shown in diagram) which rotates whenever energy is used, as

current flows thru the smaller coils making magnetism that unites with the magnetism of the large coil (which is energized all the time by being across the supply circuit usually 110 volts, 60 cy.) eddy currents are set up in the aluminum disk causing it to turn at a speed directly proportional to the energy passing. The holes in the disk open circuit the very small eddy currents caused by the potential coil, preventing more than a half revolution when no energy is being consumed in the circuit.

The magnets of very high grade steel are necessary to regulate the speed of the disk for accurate measurement and to maintain the speed directly proportional to the energy passing. There is in addition a small device to overcome by a little additional torque the inherent friction or inertia of the disk so that very small loads can be accurately recorded.

The dial or register of a meter is read identically as that of a gas meter from right to left setting down first units then tens, etc. This is necessary especially for the amateur as alternate pointers on the dial rotate oppositely in direction.

The Foot Candle Meter

D. E. COGAN, GENERAL ELECTRIC CO.

The foot candle meter, based on an instrument devised by Dr. Clayton H. Sharp, has been developed to meet the demand for a light, compact, non-complicated instrument, which would measure the illumination intensities commonly found in artificial lighting installations. An instrument so simple that anyone could operate it; so light and compact that it could be carried anywhere; so small that readings could be taken where a large photometer could not be used and sufficiently accurate to be of real practical value. The meter is 6 inches by 8 inches by 1 inch, and weighs only three and one-half pounds.

The basic principle on which the foot candle meter operates is very simple and may be readily demonstrated by means of a piece of white cardboard containing a small opening over which has been placed a piece of white tissue paper. If the cardboard is held between the eye and a light source, the tissue paper spot will appear brighter than the white cardboard. On the other hand, if the

spot is viewed with the eye on the same side of the cardboard as the light source, the spot will appear darker than the white cardboard. If the illumination on both sides of the cardboard is the same, the tissue paper spot and the cardboard will appear to be of the same brightness.

The above principle is applied to the foot candle meter in the following way. Instead of cardboard and tissue paper, the screen consists of a piece of clear glass on which are two thicknesses of paper, the one which contains the round holes being opaque, and the other highly translucent. This screen forms one side of the

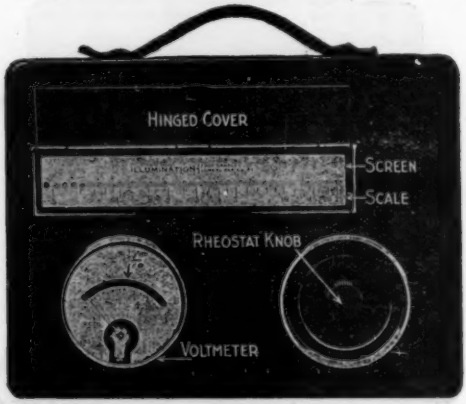


Fig. I.
FRONT VIEW OF THE FOOT CANDLE METER

light box which is so constructed that the screen is illuminated from within to a much higher intensity at the right end than at the left. The exposed side of the screen is very nearly uniformly illuminated by the light to be measured, and the round spots appear brighter than the surrounding screen at the right end and darker at the left. It is evident that at the point where the spots change from brighter than their background to darker, the illumination on both sides of the screen is approximately the same, as shown by the cardboard illustration. When the instrument has once been calibrated, the illumination intensity indicated on the screen may be read at a glance.

If readings of daylight intensities are taken, it may be found somewhat difficult to determine the points at which the spots change

from lighter to darker. This is because of the color difference between daylight and the light inside the light box. Under lighting furnished by MAZDA lamps, where the foot candle meter will be most commonly used, readings can be made much more easily and accurately.

It is obviously important that after the foot candle meter has been calibrated, the light supplied to the screen from within must be constant, otherwise all readings will be in error. A rheostat or an

Fig. II.
INTERIOR VIEW FROM REAR WITH A PHANTOM VIEW OF THE LIGHT BOX

adjustable resistance is connected in series with the lamp and battery. This permits the voltage applied to the lamp to be maintained at a constant value as the battery gradually depreciates. The voltmeter registers the voltage supplied to the lamp, and as long as the voltmeter needle is directly over the arrow on the voltmeter scale, the lamp is operating at the correct voltage to supply the proper illumination to the photometric screen. In order to read lower intensities a 1-10 calibration mark is also put on the voltmeter. When a voltmeter needle is set at the 1-10 mark, read the scale as usual and then divide the readings by ten.

The battery used in the meter is the ordinary three cell flashlight type and may easily be replaced when it becomes too weak to bring the voltmeter needle up to the calibration mark. Replacing a battery will not affect the calibration of the instrument.

The lamp used in the light box is a special lamp and this cannot be replaced without recalibrating the instrument.

In measuring illumination intensities, the operator should bear the fact in mind that his shadow, if allowed to fall on the instrument, will affect the reading to a considerable extent.

An important consideration in using the foot candle meter is to take care of the screen. This should always be clean and white. Dust or finger marks on the screen will impair its accuracy quite materially.

Some Easily Prepared Insecticides

CHARLES H. STONE, ENGLISH HIGH SCHOOL, BOSTON.

During the time that our country has been at war with Germany, the public attention has been directed, as never before, to the question of food production. To a great many people, agriculture has taken on an entirely new aspect. Tens of thousands of school children have cultivated hundreds of acres of ground and have produced a very large amount of various foodstuffs. It is to be hoped that this interest in a good work may continue.

But the experience of a few weeks often convinces the embryo agriculturist that it is not enough to prepare the ground, to plant the seed, and to cultivate the growing plant. A host of insect enemies make their appearance as soon as the plant pushes its tiny green form above ground, and they continue their devastative work until the destruction of the plant is accomplished, unless their own destruction is brought about in some swift and certain way.

It would seem appropriate, then, not only to direct efforts of the child agriculturist in the growing of food plants, but also to call his attention to some of the simple and easily prepared insecticides in common use. The following three are not dangerous to make or to handle, and may be made by any one.

Kerosene Emulsion. Weight out one gram of finely shaved soap and transfer to a flask containing 8 grams hot water. Shake gently until the soap is all dissolved. Then slowly add 16 cc. kerosene with shaking until the oil has been completely emulsified. The resulting emulsion may now be diluted with water to any desired degree. The emulsion is then sprayed upon the vines or bushes.

It should be noted that there are two classes of insects for which

an insecticide is used. These two classes are: the biting insects and the sucking insects. The biting insect devours the whole leaf of the plant with whatever may be upon the surface of the leaf. For such insects, a stomachic poison should be used, such as Paris Green or Arsenate of Lead. The sucking insects, however, do not devour the leaf, but simply suck out the juices of the plant. They are therefore unaffected by poisons on the leaf surface. Such insects may be destroyed by contact substances which clog the respiratory organs thus destroying the insect. Emulsions and certain sprays are most effective in this case.

Lime Sulphur Spray. This is used to combat the San José scale and to control fungous diseases in plants. Slake four grams good quicklime with 10 grams water. In a flask shake eight grams flowers of sulphur with 30 grams water until the sulphur is wet and there are no lumps. Heat the lime and water in a dish and pour in the sulphur and water, stirring constantly. Heat to gentle boiling for an hour or longer, stirring often and adding water to replace what boils away. When the action is complete, filter off the liquid which should be of a deep orange color, due to polysulphides of calcium. It should not be left exposed to the air as it rapidly deteriorates.

Bordeaux Mixture. Dissolve one gram of powdered copper sulphate in forty grams water. Shake up one gram of good slaked lime with another forty grams water. Both solutions should be cold. Slowly pour the copper sulphate solution into the slaked lime, shaking or stirring constantly. The resulting mixture is ready for use. As the solids settle rather rapidly, the mixture should be constantly agitated while it is being used.

In preparing Bordeaux Mixture, enough lime must be used so that there will be no copper sulphate left in solution.

The proportions in each of the three insecticides above are those for preparing small quantities in the laboratory; larger amounts may be prepared from the same materials, substituting the word "pounds" for the word "grams" in above directions.

DEAD RIGHT. Here lies the body of William Jay,
Who died maintaining his right of way,
He was right as he sped along,
But he's just as dead as if he'd been wrong.—*Ex.*

Book Reviews

The Science of Everyday Life. Edgar F. Van Buskirk and Edith L. Smith, Houghton Mifflin Co. 416 pp., 203 ill.

This book is planned for a two-year course if given in 7th and 8th grades, or for a one-year course if in the ninth grade or first year of high school.

It is organized about five major topics—Air, Water, Food, Protection, and the Work of the World. Each one of the topics is presented in a series of "projects." Each project has an introduction which gives some facts and suggests what some of the problems which follow will teach. The introduction is followed by a series of problems. In general the problems are stated and questions and directions are then given for finding the answer experimentally. A series of topics treated in regular text fashion follows the problems. Ending each main project is a list of individual projects and a list of books suggested for supplementary work.

The plan of the book requires the doing of a large number of experiments. It is suggested that these be done before studying the text. This gives the work a real science foundation. School authorities ought to recognize the need of this kind of work in science and provide proper equipment for it. The use of this book demands such equipment and if it succeeds in getting it, will have performed a meritorious service.

The attempt to get real project work from the students is something new in text-books. The book appeals to us for the new features it presents. With the right teacher there is no question but that it will give very superior results. The authors have in this book made a real contribution to education.

Health Education in Rural Schools. J. Mace Andress, Houghton Mifflin Co. XVII+321 pp. 41 diagrams and illustrations. $1.60

This pioneer book in the field of rural health education is invaluable to hygiene teachers in rural school and may be read with profit by teachers in city schools.

The scope of the book is suggested by the chapter titles: Why health should be the first aim of the school; health conditions in the country; getting children to form health habits; studying the health of the children; securing the co-operation of parents and community; planning the course of study in hygiene; the water-supply and sewerage; war on flies, mosquitoes, and other disease-carrying insects; war on rats and mice; heating and ventilating; play and physical educational; posture and health; common colds

and the hygiene of nose and throat; the care of the teeth; the hygiene of digestion and foods; the care of the eve and ear; the measurement of the teacher's work in hygiene.

This is a very practical teacher's book, giving: (1) directions for scoring health conditions, (2) many valuable suggestions and facts in usable form, and (3) an excellent annotated bibliography. General Science teachers will find this volume worth while.

The Conservation of Food Energy. H. P. Armsby. W. B. Saunders Co., 65 pp. 75 cents.

This is a timely volume on a subject that promises to bring us problems little considered before the war. Methods of getting human food from inedible crops, the energy in human and animal foods, the efficiency of animals and overhead cost are among the subjects briefly treated. Consideration is then given to wheat, corn, barley, rye, oats, cottonseed, peanuts and milk. The energy in these which can be changed into animal products by feeding directly to cattle, sheep, pigs and dairy cows, is given; also the available energy after the milling process. The data given are the result of much research in various laboratories in several different countries.

Nutritional Physiology. P. G. Stiles, W. B. Saunders Co., 294 pp. 23 illustrations. Third revised edition. $1.25.

Nutritional Physiology comprises 28 chapters. The author passes from the physiology of single celled forms of life to the complex human being and then discusses each organ, the various secretions, activities, and their function in the physiology of nutrition. The energy changes are emphasized. Such chapters as "The Maintenance of Body Temperature," "The Hygiene of Nutrition," "Food Poisoning," and "Internal Secretions," make interesting and profitable reading for the general public. The book is too advanced for general science pupils except as a reference book, but science teachers will find much of value in it.

An Outline of the History of Phytopathology. H. H. Whetzel. W. B. Saunders Co., 130 pp., 22 portraits. $1.75.

For the first time we have in this little volume an attempt to bring together the literature which must form the basis of a complete history of plant pathology.

Starting with the earliest accounts of plant diseases recorded in the Bible, following through the Dark Era and other eras up to the present time, we are given a brief account of the men who have been the chief factors in the evolution of the science of plant pathology.

Bibliographic and biographic references are given.

The Winston Simplified Dictionary. Wm. D. Lewis and E. A. Singer. The John C. Winston Co., 800 ill. 6 color plates, 820 pp. 96 cents.

This dictionary has much to commend it. Within its covers 40,000 words are defined in simple terms. Each word defined stands out in bold type of large size making it possible to find the word without eye strain.

All words are separated into syllables and pronounced. Careful selection of words needed by elementary and high school pupils has been made. The vocabulary of science terms is particularly good, and the six colored plates are all on natural science subjects, including insects, birds, fish, flowers and trees.

When you put this compact volume into the hands of the pupils, his use of the English language will begin to improve.

Trees, Stars, and Birds. Edward L. Moseley. World Book Company. viii+404 pages, 244 illustrations and 73 bird pictures in color, $1.40.

An exceedingly interesting book; splendid for nature study. And it has more real science than the usual nature study books. It will serve well for supplementary general science study, and seems well suited to pupils of the junior high school age. Outlines in nature study there are in abundance; but for good textbooks there is great want. This book is an excellent contribution, and teachers will find it a good friend.

What to Make

Electric Fountain. P. 103. Sc. Am. Feb. 1, 1919.
An Electro-therapeutic Apparatus. P. 16. Eng. Mag. Apr. 1919.
Electric Battery Tester. P. 795. Pop. Sc. Mo. May, 1918.
An Illuminator for an Enlarging Camera. P. 71. Ev. Eng. Mag. May, 1919.
A Manometer Flame Apparatus. P. 81. Ev. Eng. Mag. May, 1919.
Homemade Batteries. P. 82. Ev. Eng. Mag. May, 1919.
A Two-slide Tuning Coil. P. 83. Ev. Eng. Mag. May, 1919.
A Tube for Developing Films. P. 127. Pop. Sc. Mo. May, 1919.
How to Make a Lung-tester. P. 114. Pop. Sc. Mo. May, 1919.
A Simple Base for a Small Battery Lamp. P. 119. Pop. Sc. Mo. Jan. 1919.
Vases from Electric Light Bulbs. P. 124. Pop. Sc. Mo. Jan. 1919.
A Simple Magnetograph. P. 126. Pop. Sc. Mo. Jan. 1919.
Cuts for Printing from Linoleum. P. 90. Pop. Sc. Mo. Feb. 1919.
A Weather House. P. 92. Pop. Sc. Mo. Feb. 1919.
Dark Box for Photo Printing. P. 92. Pop. Sc. Mo. Feb. 1919.
A Height Measure for Trees. P. 86. Pop. Sc. Mo. Mar. 1919.
A Gasoline Tank Gage-stick. P. 86. Pop. Sc. Mo. Mar. 1919.
A Spotlight for the Dramatic Club. P. 98. Pop. Sc. Mo. Mar. 1919.
A Simple Electric Engine. P. 132. Pop. Sc. Mo. Apr. 1919.
A Wind-driven Merry-go-round. P. 98. Pop. Sc. Mo. Apr. 1919.

Science Articles in Current Periodicals

AERONAUTICS

The Rigid Airship is not a Failure. Cur. Opin. 66: 173. March, 1919.

Air-Borne Commerce. Lit. Dig. 60: 10: 23: 25. March 8, 1919.

The Visibility of Airplanes. (Ill.) M. Luckiesh. Journal Franklin Institute. 187: 289-312 and 409-457. March and April, 1919.

Inspection of the Airplanes before Fight. Victor W. Page. Ev. Eng. Mag. 7: 8-11. April, 1919.

Commercial Aviation—Present and Future Possibilities. (Ill.) Victor W. Page. Ev. Eng. Mag. 7: 42-44. Apr. 1919.

High Altitude Flying in Relation to Exploration. H. Woodhouse. Geog. Rev. 7: 149-158. March, 1919.

Aerial Greyhounds of To-morrow. (Ill.) Sc. Am. 120: 400-1. April, 1919.

Commercial Future of Airplanes from an Engineer's Standpoint. C. H. Day. Ev. Eng. Mag. 7: 112. May, 1919.

Parachuting to Safety. (Ill.) W. Kaempffert. Pop. Sc. Mo. 94: 3: 44-47. March, 1919.

Small Airplanes and Transatlantic Fight. Sc. Am. 120: 427. April 26, 1919.

AGRICULTURE

Practical Facts About Planting Fruits. Gar. Mag. 29: 75. March, 1919.

Inoculating for Beans and Peas. A. B. Ross. Gar. Mag. 29: 116. April, 1919.

Agricultural Fertilizers. Sc. Am. Sup. 87: 174-5. March 15, 1919.

Farming by Natural Signs. Lit. Dig. 61: 3: 24. April, 1919.

Land, Labor and You. F. F. Rockwell. Country Life. 36: 62. May, 1919.

ALCOHOL

Freezing Point and Densities of Denatured Alcohol-Water Mixtures. C. E. Davis and M. T. Harvey. Jo. Ind. & Eng. Chem. 11: 443: 448. May, 1919.

BATTLESHIP

U. S. S. "New Mexico." (Electrically propelled). (Ill.) H. B. Gregory. Sc. Am. 120: 340-1. April 5, 1919.

BEES

Spring Cleaning in the Beehive, Country Life, 36: 76. May, 1919.

BIRDS

Birds and the Farmer: Hawks. (Ill.) P. A. Taverner. Sc. Am. Sup. 87: 212-13. Apr. 5, 1919.

Birds' Nests. (Ill.) A. A. Allen, Nat. Study Rev., 15: 43-52. Feb. 1919.

Trenton's Bird House Building Contest. (Ill.) M. M. Burris, Am. For. 25: 859-60. Feb. 1919.

The Plovers. (Ill.) A. A. Allen, Am. For. 25: 877-80. Feb. 1919.

Rails. Gallinules and Coots. (Ill.) A. A. Allen. Am. For. 25: 1001-1005. Apr. 1919.

Getting Two Birds in One Bush. (Ill.) Garrett M. Stack, Country Life, 35: 5: 43-45. Mar. 1919.

BOTANY

The Kind of Botany the World Needs Now. Cur. Opin. 66: 240. Apr. 1919.

CANALS

The Canal in Transportation. (Ill.) G. P. Gleason. Sc. Am. Sup. 87: 168-70. Mar. 15, 1919.

CATERPILLAR

The Tent Caterpillar, Nature Study and Civic Improvement. Ida A. Baker. Nat. Study Rev. 15: 58-61. Feb. 1919.

CHARCOAL

Manufacture of Charcoal as an Economical Measure. (Ill.) H. Sylven. Sc. Am. Sup. 87: 124-6. Feb. 22, 1919.

CHEMISTRY

Classification of the Chemical Elements. I. W. D. Hackh. Sc. Am. Sup. 87: 146-8. Mar. 8, 1919.

Testing Wool, Cotton and Linen. A. W. Wilsdon. El. Exp. 7: 34. May, 1919.

Some Present Day Problems of Chemical Industry. R. F. Bacon and W. A. Hamor. Jo. Ind. and Eng. Chem. 11: 470-4. May, 1919.

Enlargement of our Conception of the Chemical Elements. Cur. Opin. 66: 236. Apr. 1919.

Have We Found the Ultimate Constitution of All Matter Cur. Opin. 66: 239. Apr. 1919.

Chemical Warfare Service, Development Division. F. M. Dorsey. Jo. Ind. & Eng. Chem. 11: 281-96. Apr. 1919.

CHICAGO

Chicago Today and Tomorrow. (Ill.) W. J. Schowalter. Nat. Geog. Mag. 35: 1-42. Jan. 1919.

CHILDREN

Should We Whip Children? G. B. Shaw. Phy. Cult. 41: 5: 20. May, 1919.

CITY PLANNING

Town Planning. (Ill.) K. B. Lohmans. Am. City. 20: 421-5. May, 1919.

COAL

Blowing Money up the Chimney. Lit. Dig. 60: 13: 72. Mar. 25. 1919.

Poorer and Dearer Coal in Prospect. Lit. Dig. 61: 2: 21. April 12, 1919.

Saving the Nation's Energy—Fuel. (Ill.) A. M. Jungmann. Pop. Sc. Mo. 94: 1: 69-72. Jan. 1919.

COLORS

Newton and the Colors of the Spectrum. R. A. Houstoun. Sc. Am. Sup. 87: 236. Apr. 12, 1919.

DISINFECTING

Disinfecting with Formaldehyde. M. O. Pozen and L. V. Dieter. Jo. Ind. and Eng. Chem. 11: 448-451. May, 1919.

DOGS

A Chinese Chow Dog. (Ill.) W. A. Dyer. Country Life. 35: 6: 57-9: April. 1919.

The March, 1919, National Geographic Magazine has four articles.

"Mankinds Best Friends."

"Intimate Studies of Dogs We Know."

"Loyalty, Sagacity, Courage: Heredity of Dogkind."

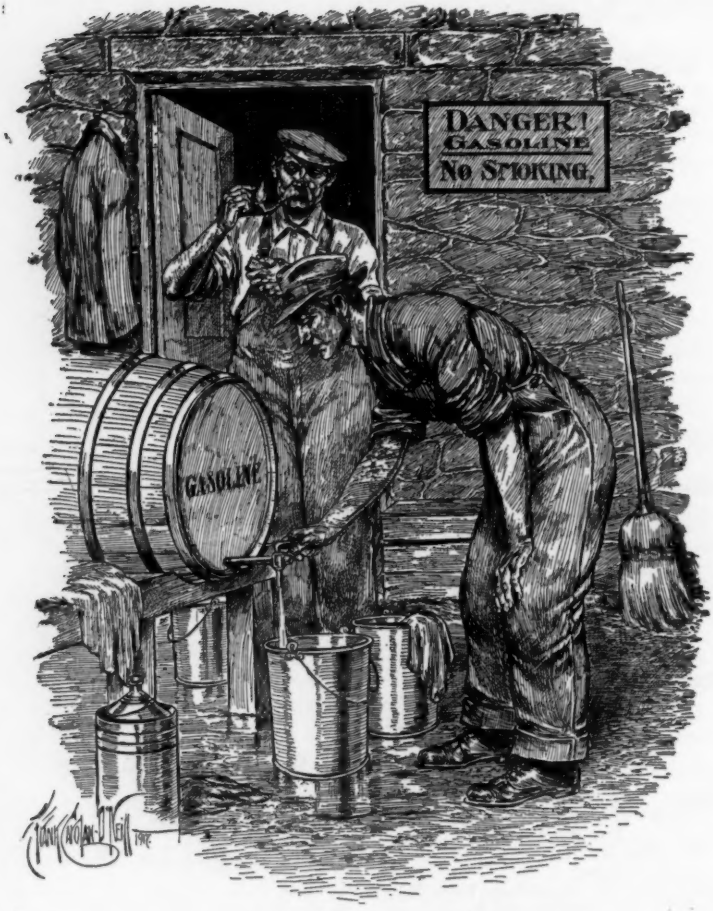
"Sheep Killers: Pariah of Canine World." These articles are illustrated with many half tones and 32 pages are in color.

DRINKING FOUNTAINS

Common Sense, Science and Drinking Fountains. (Ill.) J. H. Dunlap. Am. City. 20: 470-2. May, 1919.

EGGS

Eggs by the Pound. Lit. Dig. 61: 6: 27. May 10, 1919.



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ELECTRICITY

Electric Transmission of Power. P. M. Lincoln. Jo. Franklin Inst. 187: 365-6. March, 1919.

A New Electric Heating Record. Lit. Dig. 60: 11: 28. March 15, 1919.

Electric Heating. P. J. M. Clute. Pop. Sc. Mo. 94: 1: 98. Jan. 1919.

Lightning Arresters. P. J. M. Clute. Pop. Sc. Mo. 94: 2: 100. Feb. 1919.

ENERGY

"Blue Coal": Utilizing Tide and Wave Energy. Sc. Am. Sup. 87: 156-7. Mar. 8, 1919.

EUROPE

The Races of Europe. (Ill.) Edward A. Grosvenor. Nat. Geog. Mag. 34: 441-534. Dec. 1918.

FATIGUE

The Biological Character of Fatigue. Sc. Am. Sup. 87: 207. Mar. 29, 1919.

FIRE

Rural Fire Protection. T. A. Fleming. Am. City. 20: 227-231. Mar. 1919.

Minnesota Forest Fires. (Ill.) H. W. Richardson. Geog. Rev. 7: 220-232. Apr. 1919.

A Few Fire Don't. (Ill.) Ill. World. 31: 240-1. April, 1919.

Fire Hazards that Should be Anticipated. W. H. Murphy. Am. City. 20: 463-4. May, 1919.

FOOD

A Malnutrition Clinic. Lydia Roberts. Jo. Home Econ. 11: 95-101. Mar. 1919.

A Use of Dessicated Eggs. Lois Thamon. Jo. Home Econ. 11: 108-115. Mar. 1919.

Changes in Food Value Due to Cooking. Minna C. Denton. Jo. Home. Econ. 11: 143. Apr. 1919.

Squeezing the Water out of Food. R. G. Skerrett. Ill. World. 31: 235. Apr. 1919.

FLOOD PREVENTION

The Miami Conservancy Flood Prevention Plan. W. A. Drake. Sc. Am. 120: 282. March 22, 1919.

FLOWERS, WILD

Wild American Berries of Hill, Dale and Wayside. 29 species of American berries and blossoms reproduced in natural colors, by Miss Mary E. Eaton. Nat. Geog. Mag. 35: 168-184. Feb. 1919.

GARDEN: FLOWERS AND SHRUBS

Garden Color Scheme. Lucy E. Hubbell. Country Life, 35: 5: 35. March, 1919.

The Appeal of the Rock Garden. L. P. Wilder. Country Life. 35: 5: 29. March, 1919.

A Mystery of Flower Color. T. Rolt-Wheeler. Country Life. 35: 5: 37. Mar. 1919.

Dahlias. R. W. Waters. Gar. Mag. 29: 65. March, 1919.

Gardens and a Few Flowers. (Ill.) G. L. May. Gar. Mag. 29: 68-9. Mar. 1919.

Herbaceous Perennials. Gar. Mag. 29: 73. March, 1919.

Planting for Ornamental Purposes. Gar. Mag. 29: 74. Mar. 1919.

Hardy Phlox. Clark L. Thayer. Gar. Mag. 29: 25. Apr. 1919.

Proper Prunning of Ornamental Shrubs. M. G. Kains. Gar. Mag. 29: 160. May, 1919.

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Gardening on a City's River. (Ill.) Thomas Hastings. Country Life. 35:5:46. Mar. 1919.

Using Glass for Early Flowers and Vegetables. T. Sheward. Gar. Mag. 29:67. Mar. 1919.

Practical Guide for the Practical Gardener. E. L. D. Seymour. Gar. Mag. 29:70. Mar. 1919.

Melons Really Worth Eating. W. C. McCollom. Gar. Mag. 29: 117. Apr. 1919.

Technical Tips—Grafting and Transplanting Seedlings. (Ill.) Gar. Mag. 29:120-1. Apr. 1919.

Fruits Just for Fun. M. G. Kains. Gar. Mag. 29:122-3. Apr. 1919.

GAS

Gas Masks Absorbents, Lamb, Wilson and Chaney. Jo. Ind. and Eng. Chem. 11:420-438. May, 1919.

Stenches and Odors for Industrial Purposes. Jo. Ind. and Eng. Chem. 11:336. Apr. 1919.

Problem of Gas Warfare. E. B. Spear. Sc. Mo. 8:275-283. Mar. 1919.

Natural Gas. Pub. Opin. 66:169. Mar. 1919.

A Use of Poison-gas. Lit. Dig. 60:10:27. Mar. 8, 1919.

Continuous Vacuum Still for "Mustard Gas" (with diagram). E. D. Streeter. Jo. Ind. and Eng. Chem. 11:292-4. Apr. 1919.

A Study of Gas Consumption. Jo. Home Econ. 11:158-162. Apr. 1919.

GASOLINE

Explosion-proof Gasoline Tanks. Lit. Dig. 61:5:33. May 3, 1919.

GEOGRAPHY

The Circumference of Geography. N. M. Fennemann. Geog. Rev. 7:168-175. Mar. 1919.

GEOPHONE

A War Invention on Peace Duty. Lit. Dig. 61:4:126. Apr. 26, 1919.

Trapped in the Bowels of the Earth. Pop. Sc. Mo. 94:5:67. May, 1919.

The Geophone. Jo. Franklin Inst. 187:580. May, 1919.

GUNS

The Most Powerful Gun in Existence. Sc. Am. 120:461. May 3, 1919.

A 121-Mile Gun. (Ill.) J. B. Walker. Sc. Am. 120:312. Mar. 29, 1919.

HEALTH

The Prevention and Cure of Hookworm. (Ill.) Sc. Am. 120:334. April 5, 1919.

Bigger Business from Better Health. O. J. Hamilton and A. Denby. Phy. Cult. 41, 4 and 5:27 and 41. Apr. and May, 1919

Home Exercise for Keeping Fit. F. H. Gonzales. Phy. Cult. 41: 4:25. Apr. 1919.

How Music Affects Your Health. C. D. Isaacson. Phy. Cult. 41: 4 and 5:20 and 39. Apr. and May, 1919.

Do Germs Cause Disease? J. B. Fraser. Phy. Cult. 41:5:24. May, 1919.

Curing Disease with Milk. J. B. Galatian. Phy. Cult. 41:5:22. May, 1919.

HEATING

General Rules for Operating a Heating Plant or Stove. Pop. Sc. Mo. 94:1:110. Jan. 1919.

Ash Sifting Devices. (Ill.) Pop. Sc. Mo. 94:3:70-1. Mar. 1919.

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Mechanical Solution of Servant Problem. (Ill.) Geo. Brewster, Country Life. 35:6:52-53. Apr. 1919.

INFLUENZA

Influenza—Destroyer and Teacher. George M. Price, M. D. Am. City 20:283-287. Mar. 1919.

INSECTS

The Insect Problem in Cities. Am. City 20:225. Mar. 1919.

Insects That Attract Public Attention. (Ill.) H. B. Wiess. Sc. Mo. 8:179-186. Feb. 1919.

Familiar Insects Through the Camera. (Ill.) Sc. Am. Sup. 87: 248-9. Apr. 19, 1919.

Return of 17-Year Locust. (Ill.) W. B. Ballou. Sc. Am. 120:316. Mar. 29, 1919.

Social Wasps and Their Ways. (Ill.) H. Bastin. Sc. Am. Sup. 87:196-7. Mar. 29, 1919.

Insect Tyrants: Army Ant. (Ill.) William Beebe. Sc. Am. Sup. 87:228-9. April 12, 1919.

The Body Louse: "Cootie." (Ill.) Sc. Am. Sup. 87:229. Apr. 12, 1919.

Alien Enemies in the Pantry. (Ill.) J. J. Schoonhoven. Country Life 36:70. May, 1919.

LACQUERING

Lacquering. Arthur Weed. Ev. Eng. Mag. 7:108. May, 1919.

LIGHTING

Lighting as an Aid to the Transportation of Material. A. L. Powell and R. E. Harrington. Trans. (Ill.) Eng. Soc. 14:1-23. Feb. 1919.

Urban Rapid Transit Car Lighting. C. W. Wilder and A. E. Allan. Trans. (Ill.) Eng. Soc. 14:24-44. Feb. 1919.

Street Lighting of Buffalo. (Ill.) W. F. Schwartz. Am. City 20: 48-50. Jan. 1919.

LINOLEUM

Making Linoleum for the World's Market. (Ill.) John Morlew. Com'l. Am. 15:9:33-41. Mar. 1919.

MEDICINE

Medicine Fakes and Fakers of All Ages. (Ill.) J. A. Foote, M. D. Nat. Geog. Mag. 35:67-84. Jan. 1919.

MINES

The North Sea Mine Barrage. (Ill.) Capt. R. R. Belnap, U. S. N. Nat. Geog. Mag. 35:85-110. Feb. 1919.

MOON

Hurling a Man to the Moon. W. Kaempffert and A. J. Lorraine. Pop. Sc. Mo. 94:69-72. Apr. 1919.

MOTOR

Auxiliary Power for Bicycles. (Ill.) H. Andrews. Ev. Eng. Mag. 7:110-111. May, 1919.

NITROGEN

How the Nitrogen Problem Has Been Solved. (Ill.) H. S. M. Creighton. Jo. Franklin Inst. 187:377-408. April, 1919; 187: 599-610. May, 1919.

Nitrogen in War and in Peace. (Ill.) F. P. Stockbridge. Pop. Sc. Mo. 94:1:39-41. Jan. 1919.

NUTRITION

Review of Recent Literature on Malnutrition in Children. Lydia Roberts. Jo. Home Econ. 11:5-12. Jan. 1919.

OIL

How Long the Oil Will Last. (Ill.) Sc. Am., 120:459. May 3, 1919.

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Interesting Facts about Phosphorescence. Ev. Eng. Mag. 7: 86. May, 1919.

PHOTOGRAPHY

How the Latent Image on Photographic Plates is Developed. Sc. Am. Sup. 87: 240. Apr. 12, 1919.

A Photographic Printing Box. El. Exp. 7: 39. May, 1919.

PHYSIOLOGY

A Man With No Sense of Touch. Cur. Opin. 66: Apr. 1919.

PINE BELT

The Southern Long-Leaf Pine Belt. (Ill.) F. V. Emerson. Geog. Rev. 7: 81-90. Feb. 1919.

PIGMENTS

How Plants and Animal Utilize Color. Sc. Am. Sup. 87: 102. Feb. 15, 1919.

PLANETS

Communication With Another Planet. Cur. Opin. 66: 170. Mar. 1919.

POSTURE

How to Stand Up (Ill.) B. MacFadden. Phy. Cult. 41: 5: 27. May, 1919.

POWER

A Power Map of the U. S. Lit. Dig. 60: 13: 27. March 29, 1919.

RADIUM

Radium and Radio-activity. C. H. Viol. Sc. Am. Sup. 87: 194-5. Mar. 29, 1919.

Experiments in Radio-activity. I. Crawford. El. Exp. 7: 35. May, 1919.

RAIN

Practical Uses of Rainfall Records. (Ill.) L. M. Hastings. Am. City. 20: 459-462. May, 1919.

Rainy Days and Rain Probabilities in the United States. Robert De C. Ward. Geog. Rev. 7: 44-48. Jan. 1919.

REFRIGERATOR

Automatic Refrigerator. Pop. Sc. Mo. 94: 5: 50. May, 1919.

RESPIRATORS

Respirators, Gas Masks, and Oxygen Apparatus. Com'l. Am. 15: 10: 39. Mar. 1919.

ROADS

Width of Provincial Highways. (Ill.) W. A. McLeon. Am. City (County Ed.) 20: 214-6. Mar. 1919.

Cost of Various Types of Paving. M. W. Watson. Am. City (County Ed.) 20: 217-8. March, 1919.

Construction of Modern Brick Pavements (Ill.) W. M. Acheson. Am. City. 20: 359. Apr. 1919.

Good Roads and Health. T. H. D. Griffiths. Am. City (County Ed.) 20: 317. Apr. 1919.

Where Are the Roads? (Ill.) H. C. Campbell. Ill. World. 31: 229-233. Apr. 1919.

SAFETY

The Economics of Safety. Lew R. Palmer. Sc. Mo. 8: 350-355. Apr. 1919.

SANITATION

Smoke and Dust Elimination. C. S. Sale. Am. City. 20: 253-256. Mar. 1919.

Keeping the Pavements Clean. Am. City. 20: 103-107. Feb. 1919.

Garbage Disposal. Am. City. 20: 118-124. Feb. 1919.

Sanitation in Rural America. W. D. Pierce. Am. City (T. & Co., Ed.) 20: 119-122. Feb. 1919.

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Lifting Sunken Treasure from the Sea. (Ill.) Walter Bannard. Pop. Sc. Mo. 94:4:54-8. Apr. 1919.

Ship Launching. (Ill.) Joseph Brinker. Pop. Sc. Mo. 94:5:39. May, 1919.

SILK

The World's Raw and Manufactured Silks. J. J. Macfarlane. Com'l. Am. 15:9:16-25. Mar. 1919

SPARK PLUGS

Spark Gaps. Sc. Am. Sup. 87:198. Mar. 29, 1919.

STEEL

How the Modern Steel-furnace does its Work. (Ill.) E. Welleck. Pop. Sc. Mo. 94:2:30-31. Feb. 1919.

TELEPHONE

Chase Trouble Away from Your Phone. K. H. Hamilton. Ill. World 31:271. Apr. 1919.

Electrical and Acoustic Characteristics of Telephone Receivers (Technical). L. V. King. Jo. Franklin Inst. 187:611-625. May, 1919.

Getting More Messages Over Our Wires. Sci. Am. 120:50. Jan. 18, 1919.

Five Conversations Over One Wire. (Ill.). Elec. Exp. 6:766. Mar. 1919.

TEMPERATURES

Weighing High Temperatures in an Electric Balance. (Ill.) J. M. Bird. Sc. Am. 120:430-1. Apr. 26, 1919.

Weighing the Temperature for Blind Folks. Sci. Amer. 120:80. Jan. 25, 1919.

Ignition Temperature of Gaseous Mixtures. Sci. Amer. Sup. 87:55. Jan. 25, 1919.

TESLA

My Inventions, Nikola Tesla. Elec. Exp. 6:774-777. Mar. 1919. Elec. Exp. 6:864-5. Apr. 1919. Elec. Exp. 7:16-17. May, 1919.

TREES

Roadside Planting as a Memorial to Our Soldiers and Sailors (Ill.) R. B. Faxon. Am. For. 25:864-7. Feb. 1919.

Tree Surgery (Ill.) F. A. Bartlett. Sc. Am. Sup. 87:200-1. Mar. 29, 1919.

Fair Treatment for Trees (Ill.) E. L. D. Seymour. Gar. Mag. 29:171-3. May, 1919.

Forward with Tree Planting (Ill.) C. L. Pack. Am. For. 25:985-90. Apr. 1919.

TUNNELS

Building a Bridge under Water (Ill.) Pop. Sc. Mo. 94:5:60-61. May, 1919.

Proposed Vehicular Tunnels under the Hudson: Ventilation (Ill.) Sc. Am. 120:222. May 8, 1919.

Vehicular Tunnels Under the Hudson River. (Ill.) Martin Schreiber. Jo. Franklin Inst. 187:273-288. Mar. 1919.

Hudson River Vehicular Tunnel (Ill.) H. W. Secor. Elec. Exp. 7:10-11. May, 1919.

The English Channel Tunnel (Ill.) Sc. Am. 120:398-9. April 19, 1919.

TWILIGHT

Twilight (Ill.) Robert Wade. Country Life 35:6:60-1. Apr. 1919.

VITAMINES

Vitamines. Sci. Amer. Sup. 87:62. Jan. 25, 1919.

VENEZUELA

The Western Marcaibo Lowland. (Ill.). Theodoor de Booy Geog. Rev. 6:481. Dec. 1918.

Magazine List

American City, The Tribune Building, N. Y. C. Monthly. Two editions. City and Town and County Editions. $3.00 a year. 35c a copy. The Science problems of city and rural communities are treated in numerous articles, well illustrated. A valuable student and teacher's reference.

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WASPS

Emotional States of Wasps. (Ill.). Cur. Opin. 66:100-103. Feb. 1919.

WATER

Home Made Water Pressure System (Ill.) L. B. Robbins. Pop. Sc. Mo. 94:2:83-4. Feb. 1919.

The Color of Water. W. D. Bancroft. Jo. Franklin Inst. 187: 249-211. Mar. 1919. Jo. Fr. Inst. 187:459-485. Apr. 1919.

The Story of the Splash (Ill.) H. E. Howe. Pop. Sc. Mo. 94:5: 52. May, 1919.

WATER-POWER

To Put California Cataracts to Work. Lit. Dig. 61:31:21. Apr. 19, 1919.

Utilizing Tide and Wave Energy: "Blue Coal." Sc. Am. Sup. 87: 156. Mar. 8, 1919.

WEIGHTS AND MEASURES

The World's Weights and Measures. Lit. Dig. 60:11:27. Mar. 15, 1919.

WIND MILLS

Wind Mills; picturesque and historic; the motors of the past. (Ill.). F. H. Shelton. Jo. Franklin Inst. 187:171-198. Feb. 1919.

WIRELESS

The Rogers Underground Wireless. H. Gernsbach (Ill.) El. Exp. 6:787-789. Mar. 1919.

How I Invented the Audion (Ill.) Dr. Lee de Forest. El. Exp. 6: 790. Mar. 1919.

Do Radio Waves Travel Above the Earth or Through It? Dr. Lee de Forest and others. El. Exp. 6:872-3. Apr. 1919.

The Simon Wavemeter (Ill.) Ev. Eng. Mag. 7:25-26. Apr. 1919.

Wireless Direction Finder. Lit. Dig. 61:2:22. Apr. 12, 1919.

Wireless Telephone: The Audion Amplifier. Jo. Franklin Inst. 187:525. Apr. 1919.

Signaling and Talking Through Space. Sc. Am. 120:370-1. Apr. 12, 1919.

Trans-Atlantic Radio Reception. C. A. Culver. Jo. Franklin Inst. 187:529-579. May, 1919.

Radiophony to Airplanes a Great Success. El. Exp. 6:870. Apr. 1919.

Radio Telephony—I. (Ill.) E. B. Craft and E. H. Colpitts. Sc. Am. Sup. 87:244-6. Apr. 1919.

A Crystal Receiver for 200-Meter Traffic. (Ill.) M. B. Sleeper. Ev. Eng. Mag. 7:34-36. Apr. 1919.

The Problems of Vacuum Tube Circuits. L. M. Clement. Ev. Eng. Mag. 7:37-39. Apr. 1919.

WOOD

The Uses of Wood.

Furniture. (Ill.). Hu Maxwell. Amer. For. 24:731-741. Dec. 1918.

Wooden Artificial Limbs. (Ill.). Hu Maxwell. Am. For. 25:807-816. Jan. 1919.

Wood Finishing for the Amateur. A. A. Kluge. El. Exp. 6:793. Mar. 1919.

Wood Used in Vehicle Manufacture (Ill.) Hu Maxwell. Am. For. 25:845-952. Feb. 1919.

Uses: Boats and Their Manufacture (Ill.) Hu Maxwell. Am. For. 25:973-983. Apr. 1919.

Why Wood Is Best (Ill.) Alfred Gaskill. Am. For. 25:991-4. Apr. 1919.

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Seeing Through You Without X-Rays. El. Exp. 6:860. Apr. 1919.

Locating Stolen Diamonds by X-Rays. El. Exp. 6:862. Apr. 1919.

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